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THE MICROGRAPHIC DICTIONARY.

TEST OBJECTS.

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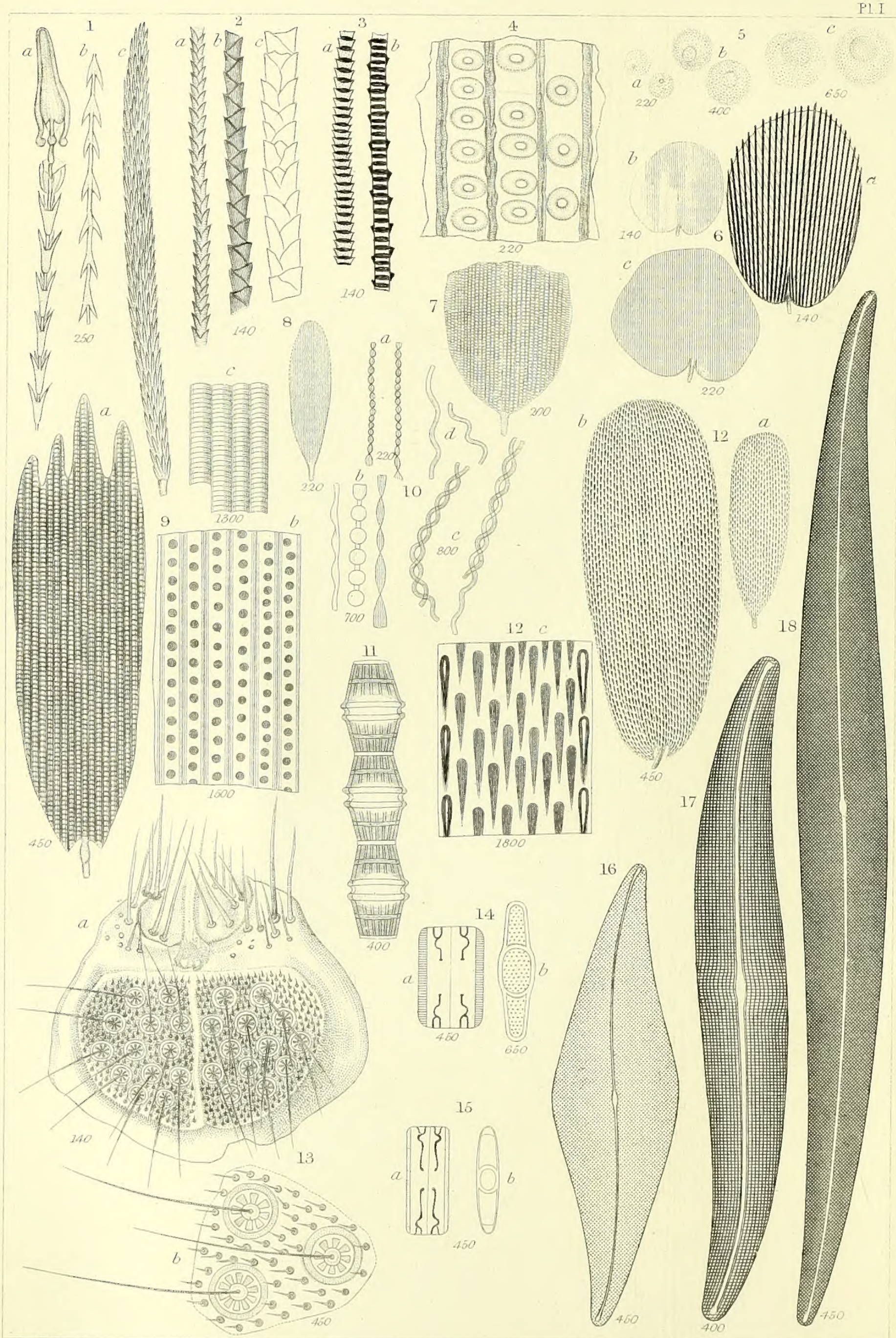

J. W. Griffith del.

H. Adlard sc.

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THE

MICROGRAPHIC DICTIONARY;

A GUIDE TO THE EXAMINATION AND INVESTIGATION

OF THE

STRUCTURE AND NATURE

OF

MICROSCOPIC OBJECTS.

BY

J. W. GRIFFITH, M.D. &c.,

MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS;

AND

ARTHUR HENFREY, F.R.S., F.L.S., &c.,

PROFESSOR OF BOTANY IN KING'S COLLEGE, LONDON.

THIRD EDITION.

EDITED BY

J. W. GRIFFITH, M.D. &c.,

AND

PROFESSOR MARTIN DUNCAN, M.B. LOND., F.R.S., F.G.S., &c.

ASSISTED BY

THE REV. M. J. BERKELEY, M.A., F.L.S.,

AND

T. RUPERT JONES, F.R.S., F.G.S.,

PROFESSOR OF GEOLOGY, ROYAL MILITARY AND STAFF COLLEGES, SANDHURST, ETC.

ILLUSTRATED BY FORTY-EIGHT PLATES AND EIGHT HUNDRED AND TWELVE WOODCUTS.

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PREFACE.

ON arriving at the conclusion of their labours, the Authors feel that some apology is, in the first place, due to the Subscribers, for the extent to which the number of these pages has been increased beyond the original estimate. They have, however, the pleasure of stating that no complaints have been addressed to them on this head, but, on the contrary, strong injunctions, when the work was somewhat advanced, to allow no considerations of arbitrary limits to prevent equal justice being done to the subjects falling under the later letters of the alphabet. They feel therefore that due allowance has been made for the difficulty of calculating beforehand the extent of a work like the present, and that the circumstance which has chiefly led to the enlargement of the volume, namely the revision of the articles at the latest moment before committing them to press, has been duly taken into account.

Secondly, a few observations may be offered on the character, objects, and uses of the work. It was stated in the Prospectus, that the 'Micrographic Dictionary' was offered as an index to our knowledge of the structure and properties of bodies revealed by the Microscope. The Authors venture to hope that their work may possess many useful qualities beyond those strictly implied in the above definition.

Few or none of the works hitherto published have dwelt upon the manner in which observers might judge of the structure of objects from the appearances presented under the microscope. There are works treating of the construction of the mechanical and optical parts of the instrument, and the manner of using them, of the methods of preparing objects for examination; and to these are usually appended lists of objects presenting interesting appearances. But there exists no work which will direct the Student how to vary the methods of preparation of the objects examined, so as to elicit their true structure.

An Introduction has been prefixed to the 'Dictionary,' affording instructions for the selection of a Microscope and the accessory apparatus, explaining the manner of using these, and particularly the precautions requisite with the less perfect but more economical foreign glasses, and, lastly, entering minutely into what may be called microscopical manipulation and the special education of the eye.

Many valuable contributions to our knowledge of the structure or functions of microscopic organisms are probably lost through the inability of microscopic observers to ascertain readily the name and position in Nature of

objects which fall under their notice. It is hoped that the very numerous illustrations to this work will form a valuable guide in such cases, and render the descriptions of microscopic animals and plants, of minute structures, tissues, &c., which form the main body of the volume, a real Dictionary of objects. At the same time it is not unreasonable to expect that much advantage may be derived from the attention that has been paid to directing observers to subjects and disputed points on which new information is desirable.

To the lovers of Comparative Anatomy, Physiology, or of the Natural History of the microscopic members of the Animal and Vegetable Kingdoms, the Authors have endeavoured to furnish, without departing from the principal purpose of the work, something more than a mere descriptive catalogue of objects, and the means of examining them. Numerous articles on various subjects have been written with a view to enable readers, by the help of the system adopted, and references printed in SMALL CAPITALS, to acquire a general knowledge of particular departments of science. Thus, taking a departure from the article ANIMAL KINGDOM or VEGETABLE KINGDOM, the reader may proceed to the *Classes* and *Orders* there enumerated; under the latter will be found a general description of these (where the microscope is much required in their investigation), followed by a reference to the *Genera*, under which is given more or less extensive information on the *Species*, according to the state of knowledge, or as the subject has seemed to require. Proceeding from the article TISSUES, in like manner, the details may be gradually collected by tracing them through the subdivisions by means of the references. Many other general articles are given, with such headings as the names of well-known organs or substances, of vital or other phenomena, &c., under which could be conveniently collected references to a variety of miscellaneous information scattered through the alphabetical arrangement. Those who use the volume in this way will probably derive the greatest amount of advantage from it; they will, it is true, most clearly perceive the deficiencies inevitable in a great measure to a work having such an extensive field, and at the same time so limited a compass.

The results of a large amount of independent observation have been consigned to these pages; and, as the bibliographical references show, recourse has been had, as far as possible, to original sources for trustworthy and reliable information published at home and abroad. In connexion with this, some account may be given of the Illustrations. In the Plates, a large number of the figures are original, drawn from the objects either by the authors or by Mr. Tuffen West; in many cases, however, figures of species have been designedly taken from original plates, especially when the verbal characters were doubtful. The Authors feel bound to express their thanks to Mr. West for the manner in which he has applied his well-known skill and accuracy to those engravings which were entrusted to him: many of them, indeed, appear at first sight somewhat crowded and on a small scale; but they will be found in most cases to display very clearly the parts of objects on which *systematic* or *structural characters* depend, the chief design of all the illustrations of this

work. With regard to the engravings in the text, a portion have been selected, after comparison with the objects themselves, from the excellent illustrations of the *Mikroskopische Anatomie* of Kölliker. Most of the woodcuts of plants are careful reproductions of drawings contained in original works and memoirs by Kützing, Corda, Tulasne, Bischoff, Bruch and Schimper, and others, prepared for Payer's *Botanique Cryptogamique,* to which, as to almost every illustration in this volume, the *magnifying power* used has been added. Had not these beautiful woodcuts been accessible to the publisher, it would have been impossible to have provided this work so richly with illustrations.

The Authors have much pleasure in acknowledging their obligations to the Rev. M. J. Berkeley, Messrs. Westwood, W. S. Dallas, Sollitt, and Tuffen West, for the loan of authentic specimens, or for information kindly afforded on various subjects, and to Dr. William Francis, for constant advice and assistance during the printing of the work.

JOHN WILLIAM GRIFFITH.
ARTHUR HENFREY.

London, December 1855.

PREFACE TO THE SECOND EDITION.

I REGRET that the task of writing the Preface to this Second Edition of the "Micrographic Dictionary" falls upon me alone, the hand of Death having just been laid upon my distinguished and most amiable friend and coadjutor. It will, however, be satisfactory to the reader to know that the whole had passed under the hands of the late lamented Professor Henfrey, and that he had taken his share in correcting for the press all but the last three sheets.

The work has been revised throughout, and has received considerable alterations and additions. The progress of Structural and Physiological Botany was always assiduously watched by Professor Henfrey; and the articles on Botanical subjects have been greatly enriched by the additions which his extensive and accurate knowledge suggested to him. Great improvements have also been introduced into many of the articles relating to the Animal Kingdom, especially in the classes Insecta, Tunicata, Polyzoa, and Foraminifera, some members of which have lately attracted much attention. The new figures added are also numerous.

The critical reader will, it is hoped, consider that the great range of subjects embraced, renders it impossible to do justice to all of them; and in

many cases we have been compelled to limit our notices to little more than the characters by which the objects are distinguishable in their respective classes, &c. This has always been a great point in the composition of the work—to enable the microscopic observer to discover what any object is which may be presented to him, and by the aid of the Bibliography to refer to more extended treatises for further details.

Our thanks are again due to those who have kindly lent us aid, especially to Mr. Dallas for the articles Aphidæ, Chalcididæ, and Cynipidæ; and also to those who supported us by their friendly notices of our former labours.

J. W. G.

December 6, 1859.

PREFACE TO THE THIRD EDITION.

AT last the Third Edition of the 'Micrographic Dictionary' is completed. But I feel that some explanation, or even apology, to the Subscribers is requisite, considering the delay that has occurred in its issue. To ill-health and press of professional engagements this is attributable. For some time, being constantly in the hope of rapidly completing the work, I hesitated to place it in other hands, until at last I found it essential to do so. The editing of the work subsequently to the letter H was therefore transferred to Prof. Duncan, whose name will form a sufficient guarantee that it has been satisfactorily accomplished.

In regard to the alterations made in this Third Edition, it will be noted that nearly 100 pages of new matter have been added. The original articles have been revised according to modern researches and views, so as to represent, as far as space would permit, the present state of knowledge.

When I state that the Articles upon the Fungi were intrusted to the Rev. M. J. Berkeley, and those upon the Foraminifera to Prof. Rupert Jones, the reader will surely feel confident that they have been carefully and faithfully elaborated. For some valuable notes on the Lichens I have to thank the Rev. W. A. Leighton.

An important novelty in this Edition consists in the accentuation of the names forming the headings of the articles. The classical pen of the Rev. M. J. Berkeley has afforded aid upon this point also.

The Plates have all been newly engraved upon copper, thus rendering the figures of the objects more sharply defined. Three new Plates have been added, and several of the original Plates have been re-arranged and improved.

J. W. G.

December 2, 1874.

INTRODUCTION.

I.—USE OF THE MICROSCOPE AND EXAMINATION OF MICROSCOPIC OBJECTS.

Before entering upon the special consideration of the Microscope, of which the Introduction treats, it may be well to make a few remarks upon the general use of the instrument in the examination of minute objects.

The Microscope will either be used as a means of affording amusement, or with a view to scientific research. In the former light, no philosophical instrument can compete with it, in regard to the great variety, the beauty, and the wonderful phenomena of structure which the minute objects it enables us to examine display, even independently of the consideration of the functions and uses of their several parts. In this light also, the investigation of the comparative structures and properties of various bodies or substances used in daily life as articles of food, dress, &c. will form subjects of intense interest to any one who may be possessed of the instrument. The mysterious phenomena of growth, reproduction, and crystallization may also be watched throughout their progress, just as we can see the effects of parts of machinery with the naked eye. But while the sense of sight is thus gratified, the mind will not be unoccupied; for every fresh appearance will impress a new fact; so that here we have both amusement and instruction combined.

It is, however, to the use of the Microscope as a means of scientific research that our remarks are most necessary; for here great care and consideration are required, and these are very apt to be neglected by those who are unaccustomed to employ this valuable instrument.

The Microscope as a means of investigation might perhaps be thus defined: the microscope is an optical instrument constructed in order to enable us to investigate the characters and properties of those objects which we are unable to study with the unassisted eye, on account of their minute size.

The use of the microscope will resolve itself into either that of proving the structure of a known object, or determining that of a new one; and in thus applying it, exactly the same precautions must be adopted, and just the same course pursued, as if the object under examination were distinctly visible to the unaided eye. The above formal definition of the true use of this valuable instrument is requisite, because it is very frequently used

simply as a means of *viewing* minute objects, and judging of their nature from the simple inspection of them under the conditions in which they naturally or accidentally occur. Such a procedure, the most casual observer must be well aware, is never trusted alone in the examination of objects visible to the naked eye, being almost sure to lead to erroneous conclusions. Consider the common course pursued in the examination with the unaided sight, of a body for the first time presented to our notice! The first point is the examination of its general appearance and colour; the relative position of the eye of the observer and the object is then changed, so that an idea of its solidity may be obtained; its weight is next perhaps determined by taking it in the hand; it is presented to the light in various ways, in order to judge of its transparency, and of the optical properties of its surface. If the object be at a distance, its size is judged of by comparing its apparent size with that of adjacent bodies, whose dimensions are approximately known; and its luminousness is also taken into consideration, it being known generally that the nearer bodies of the same size are to us, the more luminous they appear. The observer then is either satisfied with the conclusions drawn from reasoning upon the results thus obtained, or he makes besides a chemical examination.

Again, care should be taken to avoid forming an opinion upon the normal or abnormal state of an organic structure, without a previous knowledge of the natural structure of organic tissues. We therefore recommend the student, before he thinks of recording his observations, to begin by testing the structure of any objects which may come in his way, or that of the TEST-OBJECTS which we have described, according to the rules laid down in the second part of this Introduction.

It may be remarked for those who have but small means at their command, and who are unable to procure a first-rate English microscope, that perhaps very many of the facts elicited by the use of this instrument have been determined by our continental neighbours with far less perfect instruments, who have made up for the imperfections of their instruments by extreme patience, care, and repeated observation; which can be done to an extent that would scarcely have been anticipated.

We have alluded to these sources of error merely for the purpose of warning future observers, and impressing upon them the importance of making themselves acquainted with the difficulties attendant upon microscopic investigations, and with the best means of overcoming them. In fact, it may be briefly stated that the object of the present work is to guide the microscopist in his researches, to give him a notion of the manner of making these researches, also some account of the characters, microscopic structure, and properties of objects in general, and to show how he may most easily arrive at satisfactory results.

But there are difficulties inherently connected with the examination of microscopic objects, which are not encountered when objects are examined with the naked eye. One of these is that, with the ordinary microscope, objects are only viewed with one eye; hence we lose the direct power of distinguishing solidity, &c., and are compelled to resort to indirect means for these purposes. This difficulty is to some extent overcome by the construction of binocular microscopes. Again, the ordinary objects around us are also usually viewed by reflected light, whilst with the microscope they are mostly viewed by transmitted light, and we are consequently much less practised in judging from the appearances of objects thus illuminated, and are therefore liable to err.

Another, but a less important difficulty in microscopic investigations, or at least manipulations, consists in the image of the objects being inverted. Erecting eyepieces, as they are called, will obviate this difficulty; but as they are expensive, and interfere with the distinctness of the images of the objects, and as the difficulty is to a great extent got over by practice, they are rarely used.

Another very serious source of error lies in the tendency to reason from analogy as to the structure or nature of a body viewed under the microscope. Any one who pursues this course has his mind prejudiced by preconceived notions, and becomes in fact no observer at all.

It need, moreover, be merely remarked that the ordinary appearance of objects to the naked eye depends in all cases upon a molecular structure, which is generally microscopic, the ordinary appearance being the optical result or expression of this structure; and since totally dissimilar microscopic structures may present similar appearances to the unaided eye, judgment as to the nature of the former founded upon the latter can be of but little value. The reader will remember that the common capability of distinguishing objects or structures by their appearance has been derived, so to speak, from practice and experience of effects; and when we bear in mind that the experience and practice in the study of the causes are attainable, the superiority of the latter must be evident.

Next to the improvement effected in the optical construction of the microscope during the last few years, must be placed that of the method of investigation. Formerly almost all microscopic bodies possessing different forms and appearances were considered distinct beings, and were named accordingly. By the present method, prolonged observation is adopted to follow the changes which the individual bodies undergo; whence it has resulted that numbers of them have been found to be simply different stages of each other. Thus a large amount of useless nomenclature and confusion is being removed from the domain of the microscopic world.

Above all, however, it must never be forgotten that microscopic investigations require more time and patience than perhaps any others, even in regard to the determination of simple points of structure and qualitative composition. In fact, notwithstanding the innumerable observations made upon the more minute objects, such as the scales of insects, the markings on the valves of the Diatomaceæ, the fibrillæ of muscular fibre, &c., such differences of opinion are still entertained that it can by no means be asserted that the structure of these bodies is positively known.

The time has passed at which the value of microscopic research could be called in question. The wonderful insight gained by its use into the structure and functions of the various organic beings belonging to the Animal and Vegetable Kingdoms, the aid it has afforded Geology, the so-called practical applications it has permitted in improving the arts, in detecting adulterations, and in defeating crime—moreover, the almost positive certainty we have obtained that it is capable of displaying all the real structure which bodies possess, save that of their ultimate molecularity, which will probably always be hidden from us—are sufficient to deprive this question of any interest.

Lastly, if it were required to prove design in the Creation, this could not be more easily effected than by the examination of the structure of the more minute organisms.

We have expressed our intention of not entering upon a description of the microscope as an optical instrument, and this because it would have been requisite to tread widely the field of general optics, which our space does not permit. We would therefore advise those who wish to become acquainted with the microscope as an optical instrument, first to study the general laws of optics, which may be done through the medium of any of the works or treatises on Natural Philosophy, as:—the article 'Optics' by Herschel in the Encycl. Metropolitana; Brewster's 'Optics;' Lloyd's 'Manual;' the 'Natural Philosophy' of the Society for the Diffusion of Useful Knowledge; Lardner's 'Natural Philosophy,' or Mrs. Somerville's 'Connexion of the Physical Sciences.' Perhaps the second work is the best for the general reader; it is a standard work, but greatly behindhand in regard to the use of the microscope. They may then proceed to the application of

these laws to the various optical parts of the microscope. This may be found to some extent in:—the older work of Quekett on the Microscope, in which the various kinds of microscopes and accessory apparatus are figured, and their action described, with lists of objects of interesting appearance, &c.; Lardner's, Carpenter's, or Brewster's Treatises on the Microscope; the art. 'Microscope' in the Penny Cyclopædia, by Ross. The 'Observateur' &c. of Dujardin is an admirable work, in many respects the best ever written, although now old; the 'Micrographia' of von Mohl is greatly esteemed in Germany. But Harting's is the most complete work yet published.

We must not, however, omit a notice of the principles which should guide in the selection of a microscope and the accessory apparatus, because a large number of microscopes are at the present day sold, frequently at no mean cost, which, although well calculated to afford amusement, are utterly valueless for the purpose of scientific investigation. To those to whom money is no consideration, we may recommend with safety, as the best which can possibly be procured, such as are manufactured by Ross, Smith and Beck, or Powell, of London. These makers have a thorough knowledge of the instrument, and a reputation at stake; hence there is little occasion to test their instruments. But it may happen that a person may not wish to expend so much money as the purchase of these instruments requires, may wish to procure a foreign instrument (and these are cheaper), or may meet with one second-hand. A word or two may then be of service in guiding them in their choice; for a microscope may look very well and very handsome, yet be worth but little. It must, however, be borne in mind that there is much room for opinion in these matters; for according to what any one has been accustomed to, or according to prejudice arising from what he may have heard a supposed authority say, so will an instrument or a piece of apparatus be regarded as requisite or of importance, or not. Our statements rest upon our own experience in the long-continued use of the instrument, and as such they must be taken.

We may mention that, of the cheapest microscopes, the best are the "Prize Microscopes" of the Society of Arts. These are manufactured by Messrs. Field, of New Street, Birmingham, and sold by Mr. Wright, 36 Great Russell-street, London.

First, it may be remarked that the microscope is usually regarded as composed of the object-glass or glasses, and the stand, body, stage, eyepieces, &c.; and the object-glasses are generally sold separately, for by means of an "adapter" they can be applied to any microscope.

In regard then to the stand, body, &c.: the *stand* should be firm, and so heavy and its feet so arranged that the instrument cannot be easily overturned.

The *body*, both when the microscope has one body only, or is binocular, should be about 8 or 10 inches in length; in many of the foreign and cheap English instruments the body is short, and the eyepieces are adapted accordingly; but this adaptation is decidedly objectionable.

Whether the microscope shall be binocular or not must be a matter of opinion. In the binocular microscopes there are two bodies and two eyepieces, the rays of light just above the object-glass being divided by a refracting prism into two portions, one of which passes through each tube; in this way the stereoscopic view of objects is obtained. The binocular arrangement is an additional expense; it can be added to any microscope; but any binocular microscope can be used as a single-bodied instrument (See BINOCULAR).

The microscope should be so constructed that the body can be inclined at any angle desired, so that the observer may examine objects while sitting. Many persons, however, prefer to use the microscope with the body placed perpendicularly; and when chemical reagents are to be applied this position is essential; but when long-continued examination

of an object is required, it becomes very painful and fatiguing to keep the head in the position which the perpendicular position of the body requires. Moreover, as in a microscope with the joint or arrangement by which the body can be inclined the body can always be placed perpendicularly, the joint is decidedly advantageous. Again, it is almost essential when the camera lucida is used. A brass pin or some similar contrivance should be placed near the joint so as to check the motion of the body of the microscope when it reaches the horizontal position; no microscope should be without this.

In most microscopes a tube sliding within the body and carrying the eyepiece forms a "draw-tube." By drawing this out the magnifying power becomes enlarged without changing the eyepiece; it is very useful with the erector or erecting-glass (p. xx).

The microscope should have a coarse *rack-and-pinion* movement or *quick motion* for adjusting the focus of the lower powers or object-glasses; and when used with an object-glass of about half an inch focus, the image of the object examined whilst coming in and going out of focus, must not appear to move from one side to the other of the field when the body is raised or depressed by the coarse movement. Also when the milled head of the coarse movement is rotated, the motion should feel smooth, not irregular, uneven, or jerking. In some foreign microscopes, the effect of the coarse rack-and-pinion movement is replaced by the sliding of one tube within the other, the body consisting of two tubes working after the manner of those of a telescope. This arrangement is very objectionable, although used by some very good observers, who probably have more tact than most people, and who do not use such high powers as they ought; for when the highest powers are used it is perfectly intolerable. The objection is somewhat overcome in some microscopes by the existence of a fine movement; but we regard the rack-and-pinion coarse adjustment as essential.

A *fine movement* or *slow motion* is indispensable; for with the higher powers (one-eighth and upwards) it is impossible to adjust the focus without it. When the finger or fingers are applied to this in its use, no apparent motion of the object must take place; should this occur, the movement is worthless, unless, at all events, it is very slight, and this when tested with the high powers.

When the milled head of the fine movement is turned backward and forward, as in use, the motion should be perfectly even, and should be produced very easily, with slight pressure only of the finger or fingers; moreover no difference should be distinguishable between the two directions in which it is turned, but it should move with equal ease in both.

The *field* or luminous disk on which the objects viewed through the microscope are apparently delineated, should have its marginal line clear and black. If this line appear coloured, the eyepiece is not as it should be.

The *stage* should not be too small (say less than 3 inches in diameter). To the best instruments a moveable stage is adapted; but whether this is essential or not is considered a matter of opinion. Undoubtedly with low powers the moveable stage may be dispensed with, and is not often used; but with the higher powers its absence is felt greatly, and we should say that it is essentially necessary. In most of the English microscopes, whether provided with a moveable stage or not, there is a "sliding piece" for producing the backward and forward motion of an object, the lateral motion being effected by direct application of the fingers. If the body of the microscope is to be used in the inclined position, the sliding piece or a moveable stage becomes essential.

If the moveable stage be present, the "milled heads" should be pretty large, so as to be readily grasped, and a flat object should remain in focus whilst traversing the field by the movement of the stage. The stage should also be very thin.

The *mirror* should have one plane or flat face, and another concave. It should not be too small, and its centre should coincide with the axis of the body of the microscope. A double arm enables the mirror to be brought more considerably to either side, so as to throw more oblique light upon an object.

So long as the above conditions are fulfilled, the general form and arrangement of the stand and its parts are of little consequence. It must also be remembered that the complication and accuracy of the apparatus required will vary according to the kind of investigations pursued; thus the structure of the various tissues of animals, and that of most plants, can be satisfactorily studied with apparatus which is totally insufficient to display the structure of certain of the more minute and difficult objects. But, on the other hand, it follows that if a peculiar structure can be shown to exist in any kind of objects by a complicated apparatus, which cannot be demonstrated by a more simple or less perfect apparatus, the study of the structure of any object not previously examined must always be attended with uncertainty so long as it has not been tested by the more perfect kind of apparatus,—provided the microscopist has not acquired the art of replacing the imperfection of his apparatus by superior tact and management, which can be done to a great extent.

Object-glasses.—The goodness of the object-glasses depends mainly upon their freedom from chromatic and spherical aberration, and upon the magnitude of their angular aperture. The freedom from the former renders them good in defining power, *i. e.* in exhibiting clearly the margins of objects, whilst large angular aperture renders them capable of penetration, or of rendering markings upon the surface of objects visible or distinct. At least this is the ordinary statement made in regard to the relations of defining and penetrating power; but it is only partially true, and there are two kinds of penetrating power, as we shall show in the article "TEST-OBJECTS," where we have entered more fully upon this subject.

As in the case of the stand &c. of microscopes, so in regard to the object-glasses; the best are made in this country, and can be obtained of first-rate quality of the three makers above-mentioned. But the palm in regard to the highest powers must be given to Powell and Lealand, who alone construct a $\frac{1}{50}$ of an inch object-glass, and a $\frac{1}{16}$ with an angle of aperture of 175°. At the same time, the modern German immersion-lenses, as they are called (OBJECT-GLASSES), resolve perfectly most of the difficult valves of the Diatomaceæ; and they are cheaper than the English glasses. Some of the American object-glasses also, which are but little known in this country, must stand in the first rank in regard to excellence in defining, and especially penetrating power. When a glass of unknown value, however, presents itself, it should be tried upon the test-objects.

The defining power may be tested by the examination of the objects figured in Plate 1. figs. 1 to 4.

The outlines or margins of these objects must appear black, well defined, and perfectly free from colour, not misty and red or green; they should retain this appearance when the higher eyepieces are used, of course some allowance being made in regard to this sharpness of outline, which will appear slightly broader and less defined, but nowise interfering with the distinctness of the image of the object. The various parts of an object lying in the same plane, as a transverse section of whalebone, should also be visible at the same focus; the lines upon a micrometer used as a slide will also serve to test this point. It is not, however, of very great importance, especially with high powers; but it is a character of a superior object-glass.

If the definition of the glass be good, the field flat, and the power adequately high, it will also exhibit the structure of the objects in Plate 1. figs. 5, 6, 10, 12, and 13 clearly and distinctly; it is then of sufficiently good quality for nearly all the purposes required in the investigation of animal and vegetable structures. Some German and French glasses

will do this tolerably well (although many of those sold are worthless); but they are not usually provided, especially the latter, with a correcting adjustment to compensate for the effects of the varying thicknesses of the layer of liquid and the glass cover through which objects are generally seen, so that the best working of these glasses can only be obtained by accident. Still many of them are quite fit for all ordinary investigations, so long as these are carried on in a proper manner.

The exhibition of the objects illustrated by Plate 1. figs. 6, 7, 8, 9, 10, 11, 12, and 13, requires the first kind of penetrating power, but it does not require large angular aperture. The second kind of penetration, however, requires, above all, large angular aperture, independently of any other superiority; *i. e.* a glass may be perfectly corrected as to defining power, and exhibit the above objects well, yet when the valve of a *Gyrosigma* is subjected to it the markings cannot be distinguished without particular appliances, which produce the same effect as an increase of angular aperture in the object-glass. As this property is therefore principally dependent upon the angular aperture, this should be determined by direct measurement; the method of doing which is described under the article "ANGULAR APERTURE," in which also is contained a list of the various apertures of the best glasses, so that the approximation in the case of any glass to these magnitudes will afford an indication of its quality. It must be observed that increase of angular aperture in an object-glass involves an increase in price.

The following remarks may perhaps assist in guiding the judgment in regard to the selection of an object-glass:—

1. Large angular aperture is of less importance in the case of a low than of a high power.

2. Large angular aperture is neither requisite nor advantageous in physiological and medical investigations in general.

3. Whether a glass of larger aperture will exhibit any further structure than one of less aperture has already done, can nearly always be predicted from other means.

4. Object-glasses of high power and large angular aperture require to be brought very close to the objects viewed, which is a great disadvantage, rendering them useless for general investigations.

5. In regard to objects requiring large angular aperture for exhibiting their structure, much depends upon the management of the light; so that a glass may fail in exhibiting certain parts of structure in the hands of one of but little experience, whilst in the hands of another it may show them distinctly. Hence the direct measurement of the angle is best, to determine what a glass is capable of exhibiting when properly used.

6. The markings on the Diatomaceæ were discovered by the aid of foreign glasses of small angular aperture.

7. Almost all the investigations which rendered the microscope an instrument of science have been made with foreign object-glasses of small aperture; and where these have been found faulty, the fault has arisen mainly either from judging of structure by simple inspection, or substituting analogical reasoning for observation.

8. The English object-glasses are very expensive; but they are incomparably superior to the continental in every respect—in defining power, in penetrating power, in the centering of the lenses, in the existence of an adjustment for varying thickness of glass, and in general perfection of workmanship. These advantages tell principally in the higher powers. An English glass when used with the highest eyepiece will still define better than nine tenths of the continental glasses with the lowest eyepiece.

As a complete set of English object-glasses is very costly, many persons will perhaps prefer having some English and others foreign. Under these circumstances, the higher powers should be of English and the lower of foreign manufacture.

It might be objected that the structure of many of the very minute and delicate objects examined by our continental neighbours have been erroneously described; and this would be a fact. But this has arisen from unacquaintance with certain precautions essential to the proper use of high powers; and the same errors have been committed by our own countrymen, from the same cause, even with the finest object-glasses which have been made.

The student may perhaps find himself perplexed by the conflicting statements made by different renowned observers in respect to object-glasses. The illustrious Schleiden said that only a magnifying power of about 500 diameters is useful for scientific purposes, that with our present microscopes we may see whatever we like with a power of 3000, and that only the amplification of an object to the extent of 280 or 300 diameters is produced by the object-glass, all beyond this being effected by the eyepieces with an almost total loss of light. Now these statements were perhaps formerly true; but they do not apply to the modern object-glasses. The highest English object-glasses (the one-twelfth of Ross, the one-sixteenth and one-fiftieth of Powell, and the one-twentieth of Beck) will show minute objects with a power of from 600 to 2500 diameters with the lowest eyepiece, as clearly and well defined as the ordinary glasses of 1-inch focus will show larger objects; hence enormous improvements have latterly been made in object-glasses,—the increased magnifying power being produced by the object-glasses and not by the eyepieces, by which means the visible images are rendered most distinct and trustworthy.

Diaphragm.—Most microscopes are provided with a diaphragm. It consists of a circular blackened revolving plate placed beneath the stage, and having a series of circular apertures of different sizes, each of which can be brought successively opposite to the axis of the body of the microscope. It serves to regulate the quantity of light in examining transparent objects; it also reduces the angle of the cone of the reflected rays. It is seldom, however, used, nearly the same effect being produced by the two different surfaces of the mirror.

Revolving Stage-plate.—One of the plates of which the moveable stage is composed is so constructed as to revolve in the same plane upon its axis, whereby an object may also be made to revolve in the same manner. This apparatus, however, has greater disadvantages than advantages, for it renders the stage heavy and increases its depth; and the desired effect may easily be produced by rotating the slide with the fingers; moreover it is exceedingly difficult to place the object in the centre of rotation.

Spring Clamping-piece is intended to fix the slides upon the stage. It is of little use provided the slides are of the proper length, which we have given; if they are longer, the clamp will prevent the accidental displacement of an object in changing the power, &c. It serves, however, to fix the slide in viewing objects by oblique light, when the slide projects beyond the edge of the stage, and to prevent its tilting over.

Forceps are essential for holding opaque objects, such as insects, and viewing them in different positions; to allow of which, the handle of the forceps is made capable of revolving.

The *Disk-revolver* (Beck) is a very useful apparatus. It serves to bring into view all parts of an opaque object, but that which is attached to the disk.

Dark Wells are metallic cups of various sizes, blackened inside, and serving to prevent the reflection of light upon secondary stage-objects from below. They are supported in a holder, moveable in an arm which is inserted into some part of the stand or of the microscope. Their purpose is equally well effected by a slide beneath which a piece of black velvet has been fastened by marine glue.

Achromatic Condenser.—This consists of an achromatic object-glass, or set of lenses, placed in an inverted position beneath the stage, moveable in all directions in its own plane and in the direction of its axis. It serves to condense the light reflected by the mirror to

a focus upon the object, and to exclude all extraneous light. It is essential in examining minute objects with high powers; in fact, the structure of many objects cannot be made out without it. In its improved form (Gillett's condenser), a rotating diaphragm is placed behind the back glass of the combination forming the object-glass, perforated with a series of apertures of various sizes, some of them being circular, whilst others are annular—the former diminishing or increasing the cone or pencil of rays reflected from the mirror by excluding the lateral rays, the latter admitting only the lateral rays, the central ones being intercepted by the portion of the diaphragm within the ring, so that the angular inclination of the transmitted rays may be increased or diminished at will. In its most improved form it consists of two concentric revolving diaphragms, with central stops, by which the relative sizes of the apertures and stops can be varied; and its angle of aperture is 170° (Powell). In the best microscopes it is supported upon a secondary stage. The markings upon many of the Diatomaceæ can only be made out when examined by oblique light, as procured by intercepting the central rays, which effect is produced by this modified achromatic condenser. The same effect may be produced to some extent in one of the achromatic condensers of the old form, provided the compound lenses of which the object-glass in the condenser consists are separable (which should always be the case), by pasting or temporarily placing a circular disk or "stop" of black paper exactly upon the centre of the plane face of the innermost combination. The diameter of the disk should amount to about two thirds of that of the surface of the combination to which it is applied. The combinations are then fitted together as they were at first. This stop intercepts the central rays, thus diminishing the amount of light transmitted; but this difficulty is easily got over. It may be remarked that the higher object-glasses usually consist of three combinations of a doubly convex and a plano-concave lens cemented together so as to form apparently a single plano-convex lens; the outermost and smallest combination sometimes consists even of three lenses. When the achromatic condenser is used, the flat surface of the mirror should form the reflecting surface, and care should also be taken that the axis of the condenser coincides with that of the object-glass. To ensure this, a small cap of brass having a minute circular aperture in its centre should be fitted to the lower part of the tube in which the condensing lenses are situated. When the object-glass is properly adjusted with regard to the condensing lenses, the field of the microscope will appear black, excepting at a minute luminous spot. This spot must be made to occupy the centre of the field by moving the laterally adjusting screws of the condenser, or the body of the microscope; as soon as this has been effected, the brass cap must be removed. Or Ross's centering-glass may be used. This consists of a tubular eyepiece cap, in which are two plano-convex lenses, so adjusted that the image of the aperture in the object-glass, and the images of the apertures of the lenses and diaphragms of the condenser, may all be seen in focus at the same time, and their centricity or excentricity determined.

The focus of the condenser must be made to fall upon the object, which can be effected by raising or depressing the condenser until the window-bars by day, or the lamp-flame by night, are brought into focus.

The paper stop may be very advantageously replaced by a blackened metallic stop placed behind the first pair of lenses of the condenser, and screwed into the top of the condenser in the place of the ordinary diaphragm. Neither of these kinds of stop equals in convenience the improved Gillett's condenser, because with the latter the number of rays transmitted or intercepted, and the degree of their obliquity, can be varied by the simple rotation of the diaphragms. The *spot-lens* is also used for the same purpose. This consists of a very convex plano-convex lens, placed beneath the stage, the central rays being intercepted by a stop.

The central stop is generally used when objects are examined with the higher powers.

The power used in the condenser will vary greatly according to the kind of object under examination. If a considerable amount of light be required without obliquity of the rays, the condensing power should be lower than that of the object-glass. If great obliquity of the rays be required, the higher the power of the condensing lenses, and the larger their angular aperture, the better. When the achromatic condenser is suitably arranged in regard to centering, and the condensing object-glass or set of lenses is properly selected and adjusted, the structure of minute objects is displayed in a manner with which those who regard the condenser as useless must be utterly unacquainted. Webster's condenser is a good and cheap form, with central stops &c. (Collins, Great Portland Street).

Extra Eyepieces.—Always one, and sometimes two eyepieces are obtained with the microscope when purchased; but the highest eyepiece which is made should always be procured: for although high eyepieces are so far objectionable that they magnify the imperfections of the image formed by the object-glass as well as the image itself, yet they frequently render parts of structure distinct which are perhaps only just perceptible with a lower eyepiece. Kellner's orthoscopic eyepiece, in which the lower lens is doubly convex, gives a very large and flat field.

Polarizing Apparatus.—This usually consists either of two plates of tourmaline, or of two Nicol's prisms. The latter are generally used, and are preferable on account of their freedom from colour. They are composed each of two half-rhombs of calcareous spar cemented together so as to transmit only one image. The prisms should appear perfectly clear and colourless, and free from scratches and veins; and when, on holding them to a light, the uppermost is rotated so as to occupy a particular position with regard to the other, no light should be transmitted through them.

The polarizing apparatus is useful in bringing to light certain peculiarities of structure which cannot be detected in any other way. A substitute may be made of two crystals of the iodo-disulphate of quinine, dried upon and cemented to circles of thin glass. In use, one is placed beneath the object, and the other on the top of the eyepiece.

Side Condenser.—This consists of a large doubly convex or plano-convex lens, or "bull's-eye," of short focus, 2 or 3 inches, mounted upon a brass arm, which slides up and down a rod placed perpendicularly in a stand. The arm should be capable of being lengthened, and the stand should be so broad and heavy that there need be no fear of its being overturned. Its use is to condense the light upon opaque objects. When used, it is placed between the object lying upon the slide under the microscope and the lamp or other source of light, which should be about 6 or 7 inches from the object, the plane surface of the lens being at right angles to the direction of the rays of light, and next the object; and the lens must be brought so close to the object that the focus falls upon the latter. Sometimes a "small condensing lens" is used to concentrate the light already transmitted through the large condenser; this is usually fixed to some part of the microscope. A doubly convex lens of much longer focus than the bull's-eye lens, about 7 or 8 inches, will be found very useful for condensing the light upon the mirror when the achromatic condenser, stops, &c. are used with the highest powers. The arm of the bull's-eye lens may be adapted to hold either or both of the lenses.

Amici's prism is sometimes useful for throwing very oblique light through a transparent object. It consists of a flattened triangular glass prism, the two narrower sides of which are convex. The third and broadest side forms the reflecting surface. The prism may be attached to a separate stand, or to the secondary stage. It is sometimes mounted on a pillar placed beneath a large brass slide, perforated in the centre. A triangular prism mounted in either of these ways forms a Reade's prism, and is used in the samer manner. Amici's prism exerts a condensing as well as reflecting action.

Lieberkühn.—Some opake objects may be well illuminated by a lieberkühn or silver cup; by which the light, first reflected by the mirror upon the concave surface of the cup, is afterwards reflected upon the object. It is not adapted for higher powers than the $\frac{1}{4}$ inch.

Wenham's Parabolic Reflector.—The discovery of the importance of excluding the central rays of light, and using a central stop for this purpose, is due to Mr. F. H. Wenham, who invented an apparatus in which this principle is taken advantage of. It consists of a brass tube fitted beneath the stage in the place of the ordinary achromatic condenser, terminated above by a hollow truncated cone, the perpendicular section of which forms a parabola, with an internal polished silver reflecting surface. At the base of the parabola is placed a disk of thin glass, in the centre of which is cemented a dark well. In use, the central rays are stopped by the dark well, whilst the lateral rays, passing up the tube, impinge upon the parabolic surface, from which they are reflected upon the lower surface of the object. This apparatus, as modified by Mr. Shadbolt, is constructed of a solid cylinder of glass terminating above in a cone, the surface of which has the form of a parabola, and replaces the silver reflecting surface—and is the form now generally used. In objects viewed under this or any other form of black-ground illumination, the light reaching the eye is all reflected from certain suitably inclined surfaces of the object. This may be proved by placing a polarizer beneath the reflector, selecting as the object some small strongly polarizing crystals. On applying the analyzer, no colour will be seen, showing that the light has not passed through the object. Hence care must be taken in drawing conclusions from the appearances.

Brooke's Reflecting Apparatus.—The purpose of this is to illuminate objects by reflected light, so that they can be examined with the highest powers. It consists of two parts; the first is essentially the same as the apparatus proposed by Mr. Wenham. The second consists of a small, flat, circular metallic mirror (a flat lieberkühn), perforated to admit the lower end of the object-glass, upon which it slides, and so arranged that the reflecting surface is in the same plane as the lower surface of the object-glass. When in use the light is reflected by the parabolic surface upon the plane reflector, and thence upon the upper surface of the object.

A number of points in regard to the colour of objects, distinction of pigment-granules from minute air-bubbles, &c. may be decided by this apparatus. In questions of elevations or depressions of surface, the light should only be admitted on one side of the tube (for which there is a special contrivance), so that it may proceed to the object obliquely from one side only; and the conclusions must be based upon analysis of the formation and arrangement of the shadows, and not upon the general appearance, because it is well known that objects, or parts of them, usually appear larger and more prominent in proportion to the amount of light reflected by them to the eye. Hence, for instance, little depressions, which are in fact extensions of surface, by reflecting more light than the surrounding flat or nearly flat surfaces, would appear very brilliant and luminous, and thus resemble elevations.

Beck constructs an *opaque illuminator* thus:—A short screw-tube, with an aperture in one side, is fitted between the end of the body and the top of the object-glass. Within the tube is a circle of thin glass, set obliquely, so that the light entering the side aperture is reflected by the circle upon the surface of the object, and passes upwards to the eyepiece. *Tolles's illuminator* consists of a prism inserted in the side of the object-glass, between the front and middle combinations, so reflecting the light entering by a side aperture upon the object.

Camera Lucida, and steel disk or *Mirror* of Sömmering.—One of these is requisite for

drawing from the microscope. The camera lucida resembles that commonly used in sketching landscapes &c., but is provided with a fitting adapting it to the eyepiece. The mirror of Sömmering is a plane mirror of polished steel, less in diameter than the pupil of the eye, supported opposite the focus of the eyepiece by a small steel arm attached to a split ring which grasps the eyepiece by its spring-action. There is one disadvantage attending the eyepiece of Sömmering, viz. that it inverts the image of objects, which the camera does not. When either of these is used, the body of the microscope must be placed horizontally, and the axis of vision be directed perpendicularly; the image of the object will then be seen upon the table, and may be traced with a pencil. In using the camera, it must be remembered that the size of the object will appear greater as the distance between the eyepiece and table is increased; hence it is best always to place the microscope in one and the same position when about to use it for drawing, so that the extent to which the objects are magnified by the same power may always be the same. The pin mentioned at page xiii is invaluable for this purpose. By placing a micrometer-slide upon the stage, and comparing the magnified image of the divisions with those on a known measure, such as a graduated rule, the magnifying power can always be checked, and any error arising from varied distance determined.

In using either the camera or the mirror of Sömmering, the eye must be kept exactly in one position, otherwise the image of the object will move. Also the field and the paper must be illuminated to nearly the same extent. One of the screens mentioned at page xxvi is very useful for excluding extraneous light.

Erecting-glass (Lister's).—This consists of a brass tube, furnished with a meniscus at the upper and a plano-convex lens at the lower end. It is screwed into the diaphragm of the body of the microscope, or that of the draw-tube. It erects the images of objects, and serves, with a low object-glass, to reduce the magnifying power at pleasure, and to facilitate dissection under the microscope.

Live-Box and Growing-Slide.—The live-box is an apparatus in which portions of liquid containing infusoria and other small animals or plants can be confined so as to prevent evaporation and allow of their being watched in a living state.

A better apparatus, however, for this purpose is my growing-slide. This consists of a piece of stout plate-glass, 5 inches long and about 2 wide. A circular aperture, of about the diameter of a test-tube, is made near one end of it. A little glass cup, formed of a portion of a test-tube cut off three fourths of an inch from the closed end, and slightly less in diameter than the aperture, is then fitted into the latter, either by pieces of cork, or by a rim consisting of a glass ring forming a neck to the cup, or in any other way. The cup should project about one-fourth above the surface of the slide; and at one portion of its margin a little groove should be ground, in which two or three threads of a lamp-wick can be placed. The cup should be covered with a circular plate of thin glass, larger than its mouth, and prevented from falling off by a disk of cork fitting the mouth, and fastened to the plate by marine glue; or the cup may be closed with a common cork, the only objection to this being that the mouth of the cup is apt to split. The manner in which the slide is used is this:—Supposing it is wished to follow the changes undergone by some minute alga or infusorium which has been detected in a drop of liquid, it is placed upon a slide and covered with thin glass; the slide is then placed upon the growing-slide in such manner that the longer dimensions of the two are in the same direction; a little ledge consisting of a strip of glass fastened by marine-glue to the growing-slide will serve to rest the slide against, and prevent its becoming displaced. Distilled water, mixed with a small proportion of the water in which the organism was living before being transferred to the slide, is next put into the cup, and a few threads of lamp-wick cotton, thoroughly moistened

with distilled water, are then so placed that one end is immersed in the cup whilst the other is brought into contact with the edge of the liquid in which the object is immersed. Thus, as the water evaporates from beneath the thin glass, the threads will afford a continuous supply, and the threads will not become dry until the whole of the liquid in the cup has become absorbed by them and evaporated. In this way we obtain the requisite conditions for the continued growth of aquatic organisms. Care must be taken, however, that the thin glass presses but slightly upon the object, and that the threads come as little as possible into contact with the portions of the slide lying between the cup and the thin glass. If the thin-glass cover to the cup fit tightly, and the thread be passed through the notch in the cup, no loss will take place by the direct evaporation of the liquid in the cup. If living organisms are kept in this apparatus, they must have the influence of light. Several modifications of this have been devised (GROWING-SLIDE).

Compressor, an instrument for the regulated compression of a minute object. The same effect can be produced by a well-made live-box, or by pressure directly applied to the thin glass covering an object by the handle of a mounted needle.

Cabinet.—A box or cabinet, containing a number of drawers, will be requisite for holding the objects. Each drawer should be numbered or labelled to facilitate reference. The objects should lie flat in the drawers, so that each may be found when required without loss of time. The cabinet should be furnished with two folding doors, so as to exclude dust as much as possible. It should also be made of thoroughly seasoned wood, oak or mahogany being the best; if made of deal or cedar, the vapour of the volatile oil of the wood will insinuate itself beneath the thin glass cover and the slide in those objects which are mounted in the dry state, and, condensing upon them and the objects, will obscure and spoil them.

It may be remarked here that the names of objects should always be written upon labels pasted (not gummed) to the slides, not merely upon the slides with a diamond. The colour of the labels should be different for each kind of object; or if the labels be composed of white paper, they should have a coloured margin; thus those of the Desmidiaceæ may be green, the Diatomaceæ yellow, &c., so that the various slides, when accidentally mixed after comparative examinations, can be readily replaced in their respective drawers.

Bell-glasses.—The microscope when in use, either constant or occasional, should always be kept under a large bell-glass the base of which fits into an annular groove made in a circular flat wooden stand. In this way it is kept from dust, and the trouble and wear and tear consequent upon putting it into a box is saved. Moreover, thus protected, an object under examination can be left without fear of injury or disturbance, and be also preserved from dust.

Several smaller bell-glasses of various sizes should also be kept at hand, under which any objects which it may not be convenient to mount for a time, or the examination of which may not be completed, can be protected.

Slides.—These are ordinarily made of glass about the thickness of common window-glass; their length is usually 3 inches, and their breadth 1 inch. The old length was 2½ inches, which I prefer; but as the aperture in the stage has been enlarged in the modern microscopes to allow of the passage of the parabolic reflector, the Amici's prism, &c., if the old size be retained, the slides will drop through the stage. Where the objects are very large, the slide must be proportionately large, and its thickness greater than usual. The slides should be made of colourless glass, so as not to interfere with the appreciation of the colour of an object. And they should be flat; otherwise the parts of the object will lie in different planes, and every motion of the slide will require new adjustment of the focus. The

edges are best somewhat ground on a copper-plate with emery, to prevent injury to the fingers or scratching the stage-plate. Very delicate structures require to be examined and mounted upon thin glass. The sides may then be frequently made of wood, sheet-zinc, tin-plate, or card-board, with a circular aperture in the middle, upon which a piece of thin glass is cemented.

Covers.—Comparatively few objects can be viewed in the dry state; hence they are most frequently immersed in some kind of liquid. To prevent the evaporation and condensation of this upon the object-glass, and to reduce the thickness of the layer of liquid to a minimum, the object is usually covered with a piece of thin glass. The form of this cover is either square or circular, and the thickness from about the $\frac{1}{50}$ to the $\frac{1}{300}$ of an inch, or even less. These covers are usually kept already cut by the microscope-makers and those who sell objects. Before use, they are best allowed to remain immersed in water for some time. Care is required in wiping this thin glass. It is usually effected by holding the cover at two opposite points of the margin between the finger and the thumb of the left hand, and rubbing the surfaces with a fold of a cloth, leather, or silk handkerchief covering the same parts of the right hand. But the thinnest glass cannot be wiped in this way without being broken. This requires to be held at the edge by the finger and thumb of the left hand applied to the flat surfaces, and to be drawn slowly through the fold of the cloth in the hand. A very thin layer of mica is useful as a cover with the highest powers, as this prevents the risk of scratching the object-glass, the lower surface of which is often flush with the edge of the brass mounting.

Dipping-tubes.—These are glass tubes varying in length from about 5 inches to a foot, and in calibre from $\frac{1}{8}$ to $\frac{1}{2}$ an inch. They are cut of the proper length by a three-square file, and the ends gently fused in the flame of a spirit-lamp. One end is then coated outside with sealing-wax and spirit, or some other coloured liquid, so that the same end may always be used for the same purpose. They are of use for removing objects from water or other liquids in which they may be contained. Suppose, for instance, it is required to examine some deposit lying at the bottom of a liquid, or an object suspended: the fore finger of the hand in which the tube is held is placed upon the upper end of the tube so as to close it; the other end is then immersed in the liquid and brought into contact with, or as near as possible to the object, and the finger removed from the upper end. Hydrostatic pressure then forces the liquid, and with it the object, into the lower part of the tube, and it can be transferred to a slide. When a tube of narrow calibre is used, the liquid and object are retained within the tube by capillary attraction; they must then be removed by gently blowing at the upper end, the lower end being placed upon the slide. The use of colouring one end of the tubes is, that the idea of applying the mouth to the end of the tube which has been immersed in some offensive liquid, as fœtid water, &c., may be set aside.

These tubes should be kept in a glass of distilled water, with the coloured ends of course uppermost.

When a large tube is used, as in removing the larva of an insect, a tadpole, &c., the quantity of liquid removed is also large, and will be more than is required on the slide. The tube should then be emptied into a watch-glass, and the object placed upon the slide or in the live-box by a camel's-hair pencil.

Forceps are in constant requisition for taking hold of minute objects, dissecting, &c. Those used for medical purposes (common steel dissecting or surgical forceps) are best. There are three points to be attended to in the selection of them. They should not be too short, *i. e.* less than four inches in length at least; the spring- (separating-) action should be very feeble; and the points should be perfectly flat and smooth where they come into

contact. If forceps are shorter than the above length, they are not easily held steadily; if the spring-action be strong, on holding an object, as in dissection, with the forceps, the attention being perhaps directed to the scalpel, needle-points, &c., the blades of the forceps separate, and the object escapes from their grasp. If the forceps have teeth or are grooved, perhaps after laying an object out upon a slide under water, or elsewhere, a portion of it becomes entangled in the teeth, and the whole displaced. Surgical "tenaculum-forceps" are very useful occasionally in injecting. These forceps lock by their own spring-action. Supposing, then, the injection is escaping from the orifice of some vessel which has been overlooked and no assistant is at hand, on including the open end of the vessel between the ends of these forceps, which may then be left hanging, it is firmly fixed, and the operator has both hands disengaged to tie it; in fact, these forceps are indispensable to the injector. They should be short, and not heavy; otherwise the vessel may be torn by their weight.

Surgical "dressing forceps" are also frequently of use; and long "œsophagus-forceps" with scissor handles are serviceable for removing portions of plants &c. from large jars or glass vessels.

Needles.—For separating the parts of minute objects, fine points are requisite; these are found in common needles of moderate size fixed by one end into the handle of a water-colour brush. These are easily prepared: the needle is cut in half by cutting-pliers; the blunt end is then forced into the stick, about half an inch in length being left projecting. Surgeon's "cataract-needles" ground down are elegant instruments of this kind, but they require to be shortened. For minute dissection of plants, all needles require pointing on a hone.

A stout sable-hair or fine bristle, inserted into a slender wooden handle, is frequently of use in isolating minute bodies, as Diatomaceæ, which would be broken by any other instrument. It is used thus: suppose we have a number of Naviculæ, or the like, in a bottle, mixed with other bodies, and we wish to isolate one for preservation. A small quantity of the deposit is taken up with a dipping-tube, and allowed to escape upon a slide in such manner as to form a narrow stripe upon it. This is then examined with the lowest power with which the object can be distinguished, and one near the margin of the liquid stripe is selected, and may easily be removed with the mounted bristle (under the microscope) beyond the margin of the liquid. The remainder of the liquid is then wiped away with a cloth, a little distilled water added to the small quantity of liquid left containing the object, and the latter moved with the bristle into the middle of the slide. The liquid is then driven off by heat, and the object is left on the slide ready for mounting. Or, when the matter is dried upon the slide, any one of the minute objects being lightly touched with the dry bristle will adhere to it; and by gently pressing or rotating the bristle upon the middle of a new slide, the object will readily be transferred to the latter. The Diatomaceæ may be easily isolated in this way.

Knives.—Ordinary dissecting knives or scalpels. The handles should be sufficiently large to allow of being firmly held.

A particular and most useful kind of knife for producing thin sections of soft bodies is that known as "Valentin's knife." It consists of two or sometimes three blades with their flat surfaces parallel, set in a handle. The blades can be fixed at any distance apart, according to the thickness of the section required. It is drawn across and through the substance, from heel to point; the section remains between the blades, and is then removed, either with forceps, or the blades of the knife are opened under water, and the section floated upon a slide immersed in the liquid. In the latter case, the action of the water upon the tissue must not be overlooked. Valentin's knife is absolutely indispensable in

the examination of animal bodies. Some sections, especially of plants, are best made with a razor.

Black and white disk.—A disk 3 or 4 inches in diameter, made of seasoned wood, and upon one face of which a piece of white paper or card-board has been fastened by paste or glue. One half of the paper or card-board is coloured black, the other is left white. This is very useful in dissecting or separating minute portions of tissues; if these are white, they become much more easily distinguished than usual when placed (on a slide) over the black part of the disk; if they are dark, over the white portion.

Leaded cork.—Some structures require to be dissected under water, as, *e. g.*, those of insects &c. These should be fixed with pins upon a piece of cork, beneath which a plate of lead, corresponding in size, has been fastened. In many cases it is advantageous to dissect these tissues under the simple microscope. An aperture may then be made in the lead and cork, and the tissue or structure stretched across the aperture, so that the light may pass through it; or it may be illuminated as an opaque object by the aid of the bull's-eye.

A trough, composed of five pieces of glass cemented together with marine glue, four for the sides and one for the bottom, will serve to hold the water and the loaded cork.

Evaporating Dish or Saucer.—It is advisable to keep one of these, with a flat bottom, always at hand filled with distilled water, in which slides and covers that have been used may be immersed. The remains of objects which have been examined are thus easily separated from the glasses, and there is but little trouble in wiping the latter clean. If held under a gentle current of water, all remains of tissues or test-liquids may be washed away from the dish—the glasses, from their gravity, remaining at the bottom.

Test-box.—A wooden box, holding from six to a dozen or more test-bottles, is indispensably requisite. The box must be divided into partitions corresponding to the size of the bottles, and the latter must be wedged between these partitions so that the stopper can be removed without fear of disturbing the bottles. The box should be covered with a lid furnished with hinges, so that no room may be required to place the lid when the box is opened. The bottles will vary in size according to option, but they should be of at least 1-ounce capacity. Each should have a stopper so prolonged as nearly to reach the bottom of the bottle, its form being either conical or fusiform. The advantages of this form of stopper are, that a mere trace or several ordinary drops of the reagent may be applied to the object as required. If a very minute quantity be desired, the lower part of the stopper is allowed to touch the inside of the neck of the bottle when it is withdrawn; and if a larger quantity be required, this proceeding may be avoided. Each bottle should be labelled, and a label should also be placed upon the upper end of the side or partition of the box near to the bottle, so that the nature of the contents of each bottle may be ascertained without removing it from the box. The general advantages of this apparatus are, that the quantity of reagent required can be obtained to the greatest nicety, and it can be added to the exact spot required with one hand only, so that the other can be employed to hold the slide and object &c. Mr. Ferguson, of Giltspur Street, supplies these at a small cost, after our pattern.

Reagents or test-liquids.—Some of these should be kept in the test-bottles; but larger quantities should also be kept in other stoppered bottles. We give a list here of those test-reagents which are most frequently required; the method of preparing each, the strength, &c. will be found under the respective heads.

1. Sulphuric acid. 2. Nitric acid. 3. Acetic acid. 4. Caustic potash. 5. Chloride of calcium. 6. Aqueous solution of iodine. 7. Oil of turpentine. 8. Glycerine. 9. Acid nitrate of mercury (Millon's test-liquid). 10. Distilled water.

Ether or the cheaper benzole, and alcohol, should also be kept at hand. Chromic acid

should be preserved in a wide-mouthed stoppered bottle, and its solution prepared when requisite, as it easily becomes decomposed by dust &c.

Troughs are flat, oblong glass boxes, without lids. They are made of pieces of glass cemented together by marine glue, and are used in examining the larger aquatic plants or animals in a living state; also in mounting objects.

Divided Scale.—A metallic or ivory scale divided into 100ths, &c. of an inch, is indispensable in micrometric admeasurements (see MEASUREMENT). The metal or ivory should extend beyond the graduated portion.

Micrometer.—A glass slide with fine lines scratched upon it with a diamond, these being $\frac{1}{1000}$th of an inch apart, is absolutely requisite. Another, with coarser divisions, is also required to be placed in the eyepiece, for making measurements (see MEASUREMENT).

A rectangular *brass table*, with two legs at one end and one at the other, is useful in macerating objects upon slides in chemical reagents, oil of turpentine, or Canada balsam, and in mounting objects. It is heated by a small spirit-lamp placed beneath.

Ring-Net.—A very useful piece of apparatus for collecting Desmidiaceæ, Diatomaceæ, &c., where entangled amongst Confervæ, &c., or forming crusts or films upon other aquatic plants, consists of a brass or wooden ring about 4 inches in diameter, furnished with a groove round its circumference, in which also a radial aperture exists, through which the end of a stick may pass. A piece of very fine muslin, rather larger than the ring, is then laid over it, and the margins of the muslin fixed in the groove by means of a vulcanized Indian-rubber band. Or this apparatus may be so modified, that the muslin is fixed by means of an inner ring, adapted to the outer, but incomplete at one point of its circumference, and with a projecting rim to prevent its passing through the outer ring. Thus we have a kind of strainer; and by using several pieces of previously wetted muslin in succession, a large number of the minute organisms may be separated from the water. The pieces of muslin may be brought home, folded up, in wide-mouthed bottles, separately, or several in one, according as the organisms are obtained from one or several waters. In this way we save carrying a large quantity of water. The pieces of muslin are afterwards opened and placed in jars of filtered river-water, and exposed to the light, when the organisms will become detached.

A simple microscope, or some apparatus which will allow of dissection with the aid of lenses, is essential, provided an erecting eyepiece or the erecting-glass (p. xx) be not at hand. It is of little consequence which be selected, provided a large and firm sloping arm-rest be furnished on each side of the stage. Either doublets or the lower powers may be used. Some of the modern simple microscopes are binocular.

Leather Case and Collecting-Bottles.—The Diatomaceæ, Desmidiaceæ, and other smaller Algæ, as also the Infusoria, require to be collected and brought home in bottles. These should be of about 1 or 2 ounces capacity; and for portability without risk of being broken, they should be packed in a case made of stout leather, with a separate space for each bottle. The whole will pack up in the form of a book. These are manufactured by Ferguson, of Giltspur Street.

Having given a sketch of the most important pieces of apparatus, we will say a few words upon the illumination.

Illumination.—The best light in general for microscopic purposes is undoubtedly daylight, or that of the sun reflected from the clouds; and this is certainly the light which can be borne for the greatest length of time without injury to the sight. The position of the observer is of importance; it should be such that the window is on his left hand, or even the back slightly turned towards the window. The advantages of this position are great; for then but little light will enter the eyes directly from the window, and it is of

the greatest importance, during a microscopic examination, that the least possible amount of light should be admitted to the eye, from any source, besides that transmitted through or reflected from the object. In drawing also with the camera lucida this position should be strictly observed; for all extraneous light which would interfere with the distinctness of the image is thus excluded, and the shadow of the pencil and hand does not interfere with or obscure the sketch in progress, which would be the case if the observer's right hand were towards the window. But in daylight, the light entering the eye from the window, even in the position above mentioned, will interfere with the observation, unless a preventive be employed, which is to place a screen, either supported upon a stand or fixed to the upper part of the body of the microscope, between the eye and the eyepiece of the microscope and the light. This screen may be made of card-board or thin wood, covered with black velvet. If it be fixed to a moveable arm, like the lens of the side-condenser, it may be easily placed in any convenient position. If to be fitted on the microscope, it may be constructed thus: a piece of stout card-board, of about the size and shape of one of the plates of this work, should have the corners rounded off, and should be bent at a right angle at about the lower one-fourth; a hole being cut in the middle of the smaller portion, of a size just to fit the top of the body of the microscope, a short tube of card-board is then made by sewing or pasting, and this being fastened in the same way to the circular aperture serves to keep the screen in position. The whole is then covered with black velvet. When used, the long flap should be placed towards the left side; it then shelters the eye and upper part of the eyepiece from the light. A screen of this kind should always be kept upon the microscope, for it is of the greatest service. A tube made of a roll of card-board, fastened to the inside of the angle of the screen described above, will serve to fix it to the stem of the side-condenser; it may then be made to slide upon this axis or stem at pleasure. It is hardly possible to use the high powers of the microscope by daylight without a screen of this kind.

But few persons have the opportunity of using daylight for microscopic researches, and with the highest powers ordinary daylight is by no means sufficient; hence artificial light of some kind is called into requisition; and the most common source of this is an Argand lamp with oil. For ordinary purposes this answers well, although the best for examining Diatomaceæ, &c., is a Paraffine-oil or camphine-lamp, especially when stops and very high powers and eyepieces are used, whereby a large amount of light is intercepted. In "Fiddian's lamp," the flame is enclosed in a metallic case, so resembling a bull's-eye lantern, the light escaping from a round orifice only; hence no extraneous light can reach the eye. The lamp must slide up and down the stem, so that it can be placed at any height; and it should be furnished with a shade, also moveable. A white-cloud earthenware shade has recently been recommended. Norman's paraffine-lamp, and Collins's Bockett lamp, with an attached bull's-eye, are good lamps.

Much of the success with which the structure of an object is displayed, will depend upon the manner in which the light is thrown upon or transmitted through it. In general the more light that can be condensed upon opaque objects the better; and when the various parts of such objects are of different colours, the more direct the light and the greater the angular aperture of the object-glass, the more clearly will the parts be distinguishable; while in certain opaque objects which present questionable elevations or depressions on their surface, great obliquity of the incident light is essential. With transparent objects it is sometimes desirable to diminish the amount of light more or less; which may be done, either by means of the diaphragm, by using the flat instead of the concave face of the mirror, or by inclining the mirror to one side. It must not be forgotten, in determining

the cause of the better display of an object by the substitution of a less amount of oblique light for a larger amount of direct light, that it need not necessarily arise from the obliquity; for in many instances the cause is simply the diminution of light, whether direct or oblique being a matter of indifference. When the mirror has only one reflecting surface, the amount of light may be diminished by removing the lamp to a greater distance from the mirror. But the difficulty usually found consists in the amount of light being too small instead of too great. This arises from bad management, and may be overcome by attention to the following circumstances: the mirror must be placed as near the lamp as possible; if it cannot be brought within a few inches of the lamp, the shallow bull's-eye condenser must be made to condense the light upon the mirror: with the object-glasses of high powers the achromatic condenser must be used; and the lower the power of the condensing lenses, the greater will be the amount of light transmitted. The lined appearances presented by many objects, require for their exhibition very oblique light, which may be obtained by first raising the mirror as near as possible to the plane of the stage, and then bringing it as much to one side or the other of the stage as can be done; Amici's or Reade's prism is very useful for producing the same effect in a greater degree; large angular aperture in the object-glass is also very advantageous under these circumstances, because it will allow of the admission of rays of such a degree of obliquity as could not enter one of smaller aperture.

In cases where still more light is required than can be obtained in any way by reflection from the mirror, this must be turned aside, and the direct light of the lamp used, thus: clamp the slide so that the object projects beyond that side of the stage which is nearest the lamp. The body of the microscope is then rotated so that the object-glass is over the object and fixed by the milled head; the axis of the body being then directed to the light, the object may be brought into focus; and by moving the lamp around the microscope, light of any obliquity may be made to pass through the object. This is a simple way of obtaining the most oblique light, and as the light comes directly from the lamp, there is no loss from reflection, as in the use of prisms. By a little variation of this arrangement, the light may be made to fall very obliquely upon opaque objects, especially if uncovered.

Many years ago I suggested a method of remedying the defects of artificial light, or that ordinarily used to replace daylight. The well-known glare attending lamp- or candle-light, and the predominance of a yellow colour, so visible when compared with daylight, render it very unfavourable for microscopic purposes. It was proposed to mix some substance with the combustible which during its combustion evolved a light of the colour complementary to (or forming white light with) that predominant in the artificial light, or to pass the light in its passage from the artificial luminary through a piece of glass of such colour as to intercept or check the objectionable rays. As these rays are of a yellow or reddish-yellow colour, the colour of the glass must be blue, or purplish blue; but the exact shade must be obtained by experiment. Thus: the lamp, or whatever source of artificial light it may be, is lighted in the daytime, and the light transmitted through the microscope by reflection in the ordinary way, when its intensely yellowish colour is very obvious. Pieces of glass of different colours are then separately placed at right angles to the path of the rays from the lamp to the mirror, either close to the flame (in the form of an ordinary lamp glass), upon the face of the mirror itself, beneath the stage, or in an extra head of the side-condenser. If the glass be of the proper tint, and be placed at the proper distance from the light, and in the proper situation, the field will appear as white as the light of the clouds, which may be easily proved by altering the inclination of the mirror so as to reflect the light of the clouds and the lamp alternately.

It may be remarked that the nearer the coloured glass is placed to the flame the less apparent effect will be produced, *i. e.* the more will the yellow colour be perceptible, and *vice versâ*. If the field still appear yellow, the glass is not of sufficiently deep colour; if it appear blue, the colour of the glass is too deep. The first method, or that of mixing some substance with the combustible (oil, tallow, &c) capable of evolving a light of the requisite tint to form white with the yellow of the artificial light, would be far preferable to the latter method; but I am not aware that any experiments have been made to carry out this idea. It would have two great advantages, viz. that there would be no diminution of light, and that the entire apartment would be illuminated by a light equivalent to that of ordinary day. The second method has one objection, which is, that it intercepts a large quantity of the light, so that in the examination of those objects with high powers which require intense illumination, or where much of the light is arrested by stops, it is decidedly objectionable. The advantages which the use of the blue glass possesses are, that it softens the light very much, and that it enables the observer to discriminate between colours as in ordinary daylight.

A few years after the publication of the above method, a patent was taken out for the construction of lamp-glasses of a blue colour; but they are of little service, merely slightly softening the light, or intercepting a small proportion of the yellow rays.

The proper way would be to "flash" the properly tinted blue glass upon one side of a pale blue lamp-glass, so that by simply turning the glass round, the light might be transmitted through either of the differently coloured portions. Rainey's "Light-modifier" acts upon this principle. Numerous other pieces of apparatus and ingenious contrivances will be found described and mostly figured in Carpenter's 'Microscope, &c.' 1868.

II.—GENERAL METHOD OF DETERMINING THE STRUCTURE OF MICROSCOPIC OBJECTS FROM THE APPEARANCES WHICH THEY PRESENT UNDER VARIOUS CONDITIONS.

Microscopic and histological appearance, structure, and analysis.—Before proceeding to this, let us define what is to be meant by the structure of a microscopic object. If we take a piece of the free end of the finger nail, and examine a thin transverse section of it under the microscope, we find it to present numerous shorter or longer dark and somewhat irregular lines running nearly parallel to the surfaces. These appearances do not vary essentially whether it be examined in the dry state, or immersed in water or oil of turpentine.

But when it is moistened with solution of potash, and allowed to remain so for some time, or the slide is gently heated, it becomes entirely resolved into a number of nucleated cells; and by watching the gradual action of the potash, it is easily seen that the cells were originally flattened and arranged in layers, which layers produced the lined appearance mentioned above (see the article NAILS). Now which is to be considered as representing the structure of the nail? the first or the second of the above results? Undoubtedly the second. The expressions microscopic structure and histological structure are used very indefinitely, and often synonymously; but the former may very conveniently be restricted to signify the apparent structure as determined with the aid of ordinary mechanical means; whilst the latter may designate the true structure in relation to development. It may at first sight appear very unnecessary to make any distinction between the two; but it is really very important, and many of the descriptions of the structure of bodies, given in books, refer only to their microscopic structure.

The determination of the histological or true structure is often very difficult. Frequently a week or a month must be devoted to the determination of a single point. Take the instance of a hard structure—a piece of the skeleton of one of the Invertebrata. A few sections may exhibit cells, laminæ or fibres, according to the preconceived notions of the observer; whilst the histologist will not express an opinion until the inorganic matters have been removed by long maceration in acid, the calcareous salts thoroughly washed away, and attempts have been made to resolve the organic basis into its histological elements by appropriate means. This may require very many experiments to be made, and no mean knowledge of particular branches of science for guidance in the selection of appropriate agents requisite for their performance. We shall have frequent occasion to use the above words in the restricted sense; hence this should not be forgotten. The word analysis will have the same meaning as that generally attributed to it, the ultimate products being morphological.

A general method of determining the structure of objects can hardly be laid down, it must vary so greatly according to the nature of the objects and their size. The first point is to render them transparent, if not already so. This may frequently be done by immersion or maceration, if dry, in water, glycerine, or oil of turpentine. But the solvent power of the liquid must be borne in mind; for the organic principle aleurone was overlooked for years, from its being soluble in water, in which the sections of the albumen of seeds containing it were immersed to render them transparent. Sometimes the aid of heat is necessary, and objects may even require to be boiled in these liquids, either upon a slide placed upon the brass table over the flame of a spirit-lamp, or in a small tube. Sometimes sections require to be made, and these treated in the same manner. If soft, their elements may be separated by the aid of needles; sometimes pressure will answer the same purpose.

When the object is very minute, it will frequently be desirable to examine both sides of it with high powers. Hence it must not be placed upon an ordinary slide, on account of the thickness of the latter, but must be supported upon, and covered by thin glass. The best plan is to keep a number of slides made of tolerably stout card, wood, or tin, each having a piece cut out of the middle. A thin glass cover, rather larger than the aperture, should then be cemented by marine glue or Canada balsam to one side of the slide; the thin glass cover is then applied as usual.

A great advantage of this method of temporarily or permanently mounting objects is that, the card-board being flexible, there is no fear of injuring the object-glass, even if it should come into contact with the glass cover. If the object be very small and its structure very delicate, it must be crushed, so that some of the fragments may lie perfectly flat upon the slide. See also the article Preparation.

The points to be determined in regard to the different parts of an object, however, may be best treated separately.

The examination of a microscopic object must comprise:—*a*, the *microscopic analysis*, including,—1, the form; 2, the colour; 3, the structure of the surface; and 4, the internal structure: *b*, the *histological analysis*, in the sense already explained: *c*, the *qualitative chemical composition*: and *d*, the *measurement*.

A. Microscopic Analysis.

1. *The Form.*—*a.* This is usually judged of from the outline, as seen by transmitted light, and often erroneously. Where a low power is used, the upper surface of an object and its sides are mostly simultaneously visible: but under a high power, only those parts lying within a very limited vertical range, or in the same plane, are visible at one focus; and

the parts lying in planes above or below this can only be brought into view by altering the focus: hence the views of objects under high powers correspond to views of transverse sections of the same objects made through various horizontal planes; and as the margins of objects are usually more distinct by transmitted light than the upper surface, spherical or rounded bodies frequently appear flattened. When several bodies of the same kind are visible in the field of the microscope, some will almost always be found lying upon their sides; and even when the objects are greatly flattened, some will mostly be found lying on edge, presenting the side view.

b. But as there may be uncertainty in regard to the relation of these bodies to each other, the only safe method in forming a conclusion is to cause them to revolve or roll over, so that all their aspects may be distinguished. This is in general easily accomplished: if the object be already immersed in liquid, the inclination of the stage will answer the purpose; or a little benzole, naphtha, alcohol, or some other volatile liquid in which they are insoluble, must be added. The currents produced by the evaporation of these will cause the objects, especially such as are near the edges of the liquid, to move in all directions, and their true form may be discerned. Sometimes moving the thin glass cover sidewise, the object being kept in view, will answer the same end.

c. In figures of microscopic objects, the side view should always be exhibited if possible; and if not, it should certainly be described.

d. In the case of crystalline bodies, or such as present angular edges, their angles should be measured with the goniometer, if their chemical composition be unknown.

2. *The Colour.*—The colour of objects should always be carefully described, and its cause accurately determined. It most commonly arises from,—1, partial absorption; 2, the presence of pigment, or other colouring-matter; 3, from iridescence; 4, from polarization, &c.

(1.) The most common cause is a peculiar property by which a portion of the coloured rays composing the white light which falls upon or is transmitted through an object is absorbed, the remainder being reflected or refracted so as to reach the eye. On examining bodies thus coloured, with whatever powers, their substance is found uniformly coloured, and this colour is unchanged by their immersion in water or oil of turpentine, and is the same in transparent bodies by both transmitted and reflected light. This is commonly regarded as the *proper colour* of an object. Example: a crystal of blue vitriol.

(2.)—*a.* In many cases, however, although an object may appear to the naked eye uniformly coloured, on examining it with a high power, the colour, which in fact arises from the above cause, is seen to be confined to certain molecules or granules, whilst the general substance is colourless. These granules may consist of vegetable or animal colouring-matters, metallic oxides, &c. The nature of these matters should always be determined, if possible, either by microscopic chemistry—micro-chemical analysis, as it has been called, —or by ordinary chemical analysis. When the colouring-matter is of organic nature, and when its composition cannot be determined, or it has no definite name, it is called *pigment.* Objects coloured by pigment, metallic oxides, or other colouring-matters, are best examined by direct (not oblique) transmitted light, and when immersed in either water or oil of turpentine. These liquids do not change the colour, nor destroy it unless the pigment be soluble in them; but by rendering the general substance of the object more transparent, they cause the granules to become more distinct. The colour is the same both by transmitted and reflected light. Example: a brown or black hair of an animal, as the mouse.

b. Sometimes bodies coloured by pigment or other colouring-matters appear under the microscope uniformly dyed, although the colouring-matter consists of an insoluble molecular or granular powder—as a white animal hair first macerated in solution of ferrocyanide of

potassium and then in solution of perchloride of iron. Chemical means will alone distinguish this cause of colour from the first, by removing the colouring-matter from the colourless basis.

(3.) The colours of many objects vary according to the direction of the light transmitted through them, or are only visible by oblique light, and the colours are different by direct and oblique light. These arise from decomposition of white light by either interference or refraction. For the sake of brevity, these may be designated *colours from iridescence*, because they mostly exhibit the brilliancy and transparency of the colours of the rainbow. The interference or refraction upon which they depend is ordinarily produced by irregularities of structure, frequently depressions or grooves, and sometimes cavities containing air, &c. Objects exhibiting these colours, which are most brilliant by very oblique light and under low powers, when examined with a moderately high power by transmitted direct or but slightly oblique light, frequently appear more dull and less brilliant, often dark or black in parts; and when immersed in oil of turpentine or some liquid approaching in refractive power the substance of which they are composed, so that their irregularities become filled with it, the colours vanish. Hence colour, when arising from iridescence, can readily be distinguished from that arising from general absorption or from the presence of pigment; and when the colour of an object obeys the above law, it may be predicted that structural irregularities sufficient to account for its production will be found if properly sought for. Moreover these colours are not the same by reflected and refracted light, and they vanish under very high powers. They may be studied in the species of *Gyrosigma*; and those observers whose microscopes do not magnify sufficiently, or whose object-glasses have not sufficient angular aperture to admit of the detection of the markings upon some of the Diatomaceæ or other bodies of similar structure, may be sure that they are present when these phenomena have been observed. We were thus led to search for them upon the valves of *Melosira varians*, and *Borreri*, species of *Nitzschia*, &c., where they had not been previously detected; and there they are present. Again, the colours of the dried valves of the Diatomaceæ, many of which have a brown tinge, have been supposed to depend upon the presence of the peroxide of iron; but as this colour vanishes when the valves are immersed in oil of turpentine, independently of the fact that the valves do not present the same brown colour by reflected and transmitted light, and by direct and oblique light, which we have stated to be characteristic of the presence of colouring-matter, the colour cannot arise from this cause.

An example of iridescent colour arising from the presence of fibres, is found in the tapetum. Certain cases, referable to this head, require special notice. Thus it sometimes becomes a question whether a very minute red spot, visible in an Infusorium, Alga, &c., is the optical expression of a minute vacuole, or a little depression filled with water, air, or other fluid of less highly refractive power than the substance of which the organism consists, or whether it arises from the presence of pigment. The point is easily decided: a practised eye will recognize the transparency of the colour where not arising from pigment, and its granular appearance where the pigment is present. If the substance of the object be soft, compression will frequently destroy the appearance when pigment is absent. Drying the object and then immersing it in oil of turpentine or other highly refractive liquid will do the same, whilst pigment will become even more distinct if present. Moreover, on altering the focus of the object-glass, the colour will be found to change, when not arising from pigment.

The colours of thin plates are so rare in microscopic objects, that we must refer to works upon optics for an account of them. They occur in the crystals found upon the surface of the scales of various fishes, the eggs and wings of insects, &c.

(4.) The colour arising from polarized light is noticed under ANALYTIC CRYSTALS, DICHROISM, and POLARIZATION.

The colours of objects examined by transmitted light are frequently rendered much darker, and colourless or coloured objects may appear dark or even quite black, from refraction or reflection of the light out of the field of the microscope. Thus powdered vermilion appears almost black; air-bubbles appear black at the margins or entirely black, &c.: hence the importance of comparing observations made by both reflected and transmitted light; for neglect of this precaution caused the air in the hairs of animals to be mistaken for pigment. Milk-white opacity mostly arises from the presence of numerous molecules, granules, thin layers of liquid or other surfaces which reflect a large quantity of the light incident upon them, as in milk—where the reflecting bodies consist of the globules of fatty matter (butter),—white paper, tubercle, &c.

3. *Structure of the Surface.*—*a.* When an object is of comparatively large size, the structure of the outer surface is in general easily determined by examining it with reflected light, *i. e.* as an opaque object, illuminated by the Lieberkühn or side-condenser; but when the objects are small, sufficient light cannot be thrown upon them with ordinary condensers; recourse must then be had to Brooke's reflector, or the opaque reflectors mentioned at p. xix.

b. The appearances presented must also be controlled by those resulting from the action of transmitted light. And here we meet with a difficult task, in accomplishing which, the following questions are constantly presenting themselves:—Do certain spots, lines, or other markings visible upon the surface represent elevations or depressions? Are they cavities in the outer portion or layer of the object? Are they foramina or holes? Are they granules of pigment, or rows of them? Do the lines represent a true lined structure, or are they optical illusions? Is the surface smooth and free from markings? The methods of answering these questions must vary so greatly, according to the nature of the object, its size, &c., that it would be almost impossible to lay them down by rule. The following considerations, however, are of most importance.

c. In many cases where structural appearances are visible at the surface of an object, their true situation above or beneath the surface may be determined by raising the object-glass above the focus of the surface. On then carefully and gradually depressing the object-glass with the fine movement, the structure first brought into focus is the uppermost. Thus, the inner surface of the under membrane of the elytrum of the stag-beetle (*Lucanus cervus*) is covered with very minute hairs projecting from the surface (Pl. 27. fig. 2). On placing this with the inner side uppermost and adjusting the object-glass as just described, the hairs are distinctly brought into focus before the surface of the membrane. Hence they are situated upon the surface; whereas, had the surface of the membrane been brought into view before the hairs, it must have been concluded that the latter were situated on a plane below this. It may be stated that the surface of a membrane is recognized to be in focus by certain irregular granules, molecules, or wrinkles mostly visible upon it.

d. Frequently, when hairs, filaments, or spines project from a surface, their relative position may be determined by examining the margin of the object if it be rounded, or the margin of a fold if it be flat and membranous,—as in the case of ciliated bodies, Infusoria, &c.

e. Cilia upon the surface of an object are sometimes so minute and transparent as to be with difficulty detected; they can however always be made evident, when present, by the following means:—1. Drying the object; they then become much darker from refraction. 2. Dyeing the object with solution of iodine; drying the object after the addition of the latter solution is sometimes advantageous. 3. Mixing insoluble coloured particles, as those of lampblack, with the water in which the objects are contained; of course this is

only of use if the objects be living; the particles will then be set in motion, and their motion may be distinguished from molecular motion by the definite direction in which the particles move.

f. The nature of many markings, spots, &c. is best determined by comparing at different foci the effects of the refraction of the transmitted light produced by the markings themselves, and the substances in which they are situated; and these phenomena may be conveniently illustrated by their occurrence in known objects. If a drop of oil of turpentine, which has been digested with alkanet root so as to become coloured, be placed upon a slide, a drop of water added to it, a thin glass cover applied, and the cover be moved backwards and forwards upon the slide with the finger covered with a cloth, the drop of oil will be subdivided into globules of various sizes, some of which will enclose globules of water; thus we shall have globules of the oil surrounded simply by water, globules of water enclosed in globules of oil, and some of these globules will contain within them globules of the other kind again, the globules of oil being readily distinguished by their red colour. On examining the slide with a tolerably high power, all the globules will appear bounded by a black circle, and present a luminous point in the centre, when viewed separately, and the focus suitably adjusted for each. But when they are examined in comparison and together, they will be found to exhibit characteristic appearances according to the variation of the focus. Thus, of the simple globules, when their margin is most distinctly brought into focus, some will become more luminous as the object-glass is depressed (Pl. 40. fig. 1 *a*)—these are globules of water surrounded by oil; others will become darker under the same circumstances (Pl. 40. fig. 1 *b*), and very luminous as the object-glass is raised (Pl. 40. fig. 1 *c*)—these are globules of oil; and the nature of the components of the compound globules may easily be determined by the occurrence of the same phenomena. The globules of oil, being more highly refractive than the water, act like little convex lenses; whilst the globules of water surrounded by the oil, exerting a lower refractive power than the latter, act like concave lenses, and their centre appears luminous because the rays which traversed them diverge as they ascend, as if they emanated from a (virtual) focus situated beneath the globules, or on the same side of them as the mirror. Hence these foci may be distinguished as the "lenticular foci" of the objects. And when dots or markings are very minute, frequently all that can be distinguished under the microscope are these lenticular foci of the various parts.

The same phenomena may be observed in air-bubbles immersed in water; these correspond with the globules of water surrounded by the oil. It need scarcely be remarked that the object in colouring the oil is to allow of the control of the conclusions arrived at.

g. In the globules of sarcode and many cells, the vacuoles are easily shown by the same method, to be filled with a material of less refractive power than the general substance of which they are composed; these vacuoles are frequently mistaken for nuclei and nucleoli, but they are readily distinguished from them by the dark appearance they present when the object-glass is raised above the focus of their margins.

h. The above principles are applicable to the determination of numerous cases where the elevation or depression of a spot or marking upon a surface is called in question; for elevations on a surface will produce the general effect of convex lenses, whilst depressions will produce that of concave lenses. In the above experiment, plano-convex lenses of both oil and water are frequently seen, and readily distinguished by the above means.

Take also the instance of a *Paramecium aurelia,* either dried or immersed in water. The surface is beautifully marked with pretty regular dots, which appear luminous as the object-glass is depressed (Pl. 25. fig. 1 *a*), and dark as it is elevated (Pl. 25. fig. 1 *b*); hence

they consist of depressions upon the surface. Had they been elevations or little tubercles, they would have become more luminous as the object-glass was raised, and *vice versâ.*

When an isolated granule of pigment or of any opaque substance is brought into focus, on raising the object-glass a luminous spot appears to occupy its place; hence it agrees so far with a highly refractive granule. The appearance, however, arises from diffraction, and may usually be distinguished from that produced by refraction, by the luminous spot equalling or exceeding the granule in size, whilst in the latter it is smaller and more brilliant.

i. In all these experiments the less oblique the light the more certain will be the results. But this method is inapplicable to decide whether the less-refractive portions are simply depressions or cells. This may often be determined by examining the margin of the object where possible (as in *Paramecium*), and observing whether there are depressions upon it corresponding to the parts at which the dots are situated, and whether these depressions are continuous with the dots (Pl. 25. fig. 1*b*). When the substance of the object is somewhat firm, drying it, if moist, will cause the dots to become filled with air; they will then, if cells, appear infinitely blacker than if simply depressions, and visible as readily by direct as by oblique light; and after the object has been moistened with water or oil of turpentine, if it be immediately examined, the blackness of the dots will appear still greater, and they will be distinctly visible by direct light; whilst depressions are much more easily filled with liquid, and then, if minute, will only be visible by oblique light.

k. If it can be shown that the parts corresponding to the dots are depressed below the general surface, and the dots or depressions present an angular outline, these dots cannot possibly represent cells; because, if the angularity of the outlines of cell structures arose from the pressure of surrounding or adjacent cells, this pressure would necessarily be exerted also upon the free or external portion of each cell, so as to render it convex, or at any rate not concave. The firmness of the substance of the object must be attended to; because where it is absent, as the cells part with the liquid portion of their contents, the outer portion of the cell-wall may become approximated to the inner, and thus no space be left for the air to enter, as in the exuviæ of a *Triton* for instance.

l. In brittle objects, as the siliceous valves of the larger Diatomaceæ, the examination of the margins of crushed and perfectly flat portions is important and sometimes conclusive; for it may be found, as in *Isthmia*, &c., that the depression of the object-glass requisite to bring into focus the margins of the thin depressed portion, is much greater than that required for the intermediate thicker parts. In the valves of the more delicate Diatomaceæ (*Gyrosigma*, &c.), in which this observation is difficult to be made, the point is important that the line of fracture of the broken valves passes through the rows of dark dots or the lines corresponding to them, showing that they are thinner and weaker than the rest of the substance; had these dots represented elevations, the valves would have been stronger at these parts. The nature of the markings upon the siliceous valves of the Diatomaceæ, especially the species of *Gyrosigma*, has long formed a much-disputed point. In distinguishing in general minute points, as the little siliceous spines of the cuticle of *Equisetum*, the very short spines on the wings of many insects (*Tipulidæ* &c.), or the minute spheroids in Schultze's siliceous films, it may aid somewhat to remember that prominences are usually most distinct under open central illumination, while depressions are most evident under the central-stop illumination. If we take a flat fragment of an *Isthmia*, and examine it by the aid of the condenser with a central stop and an object-glass of low power, care being taken that the condenser and stop are perfectly central, it will exhibit a series of angular dark or black dots bounded by luminous lines separating them (Pl. 11. fig. 47), and this when all parts of the object are best in focus; for when the object-glass is elevated or depressed, the whole becomes indistinct. The black dots in this instance clearly coin-

cide with the depressed portions of the surface of the valve. On examining a fragment of the valves of a *Gyrosigma strigosum* or *angulatum* under a high power, for they are not visible under a low one, exactly the same phenomena are witnessed when the parts of the object in view are perfectly flat and appear at their most distinct focus, the black dots being bounded by angular short continuous lines, giving them the appearance of being distinctly hexagonal. On inclining the mirror somewhat, so as to render the light transmitted through the object irregular or unequally oblique, the appearances will be reversed, a number of luminous dots resembling pearls (Pl. 11. fig. 46) being visible, bounded by dark spaces. These are the lenticular foci of the little knots formed by the union of the raised bars existing between the depressed portions of the valve. In Pl. 11. fig. 41 is a diagram of a portion of a valve of *Gyrosigma angulatum*, magnified to the enormous extent of 15,000 diameters, taken from a photograph lent us by Mr. F. H. Wenham; and the same appearances may be seen under a lower power in a very large number of the Diatomaceæ. The black hexagonal dots in the latter figure correspond to the black dots seen in *Isthmia,* and represent the depressed portions of the valves. The article DIATOMACEÆ must be consulted for further details in regard to the structure of these valves, and the article ANGULAR APERTURE in regard to the changes produced in the appearances of objects by variation of the angular aperture of the object-glass, and of the degree of obliquity of the transmitted light. But we may remark here, that these dots must not be compared to cells, but to the depressions found upon the seeds of the white poppy, *Paramecium,* &c., in which forms resembling those resulting from the mutual pressure of adjacent cells are present, but do not arise, so far as we know, from this cause.

m. No special remarks are required in regard to furrows, as these are only elongated depressions.

n. When ridges are present, these are frequently left projecting at the margin of a fragment; sometimes they project naturally; and it may readily be known that they are thicker portions of structure, by their blacker margins and their exhibiting the characters of elongated convex or plano-convex lenses.

In some cases, the position assumed by confined portions of air, when the object is immersed in liquid, will denote the existence of ridges. Thus we have seen portions of air, accidentally confined between the surface of a scale of *Lepisma saccharina* and the thin glass covering it, assume an elongated form, being limited laterally by the ridges upon the scale (Pl. 27. fig. 3).

o. Foramina or holes are in general readily distinguished by their dark and defined margins, and the absence of colour when they exist in coloured structures; when existing in transparent colourless objects, the latter mostly exhibit minute irregularities, by which the presence of some kind of matter is indicated, whilst these are absent in the foramina. Where there is difficulty in deciding, the structure should be broken, if possible, and the margins examined. Sometimes the polariscope is of use; the general substance may polarize light, but of course the foramina will not do so. Charring the structure, or colouring it with reagents, if organic, will sometimes afford decisive proof.

Foramina cannot be mistaken for elevations on the surface, because they do not become more luminous as the object-glass is raised, after their margin has been brought most distinctly into focus; in fact the reverse occurs: hence they so far agree with depressions; but they differ from these in their luminous appearance with high powers, and their not being rendered more distinct by oblique light, but the reverse.

p. When the structure in which they are situated is somewhat thick, and they form rather tubes than foramina, as the axes of these can hardly coincide with the direction of the transmitted light, their orifices will appear dark or black; hence they might be mistaken for granules of pigment: immersion or maceration of the structure in oil of turpen-

tine, however, will fill them, and cause the dark appearance to vanish, whilst pigment would still be visible. Examination by reflected light will also readily distinguish the one case from the other. Also where this tubular structure is present, perpendicular sections will exhibit furrows, which may be recognized as directed above. In distinguishing foramina, the higher the power employed the less is the difficulty.

q. It has sometimes to be decided, whether certain dark lines visible at the surface of objects, represent ridges or grooves, or whether they are illusory shadows arising from the passage of light through a structure furnished with depressions, granules of pigment, &c. This must be done by examining the object when illuminated by reflected light, or a hollow cone of oblique rays, such as is obtained on using the achromatic condenser with the central stop; when thus illuminated, the lined appearance will vanish, and the true structure will become visible.

r. It often happens that objects, especially highly refractive bodies, appear surrounded or covered by a number of black lines, rings or annular lines, arising from diffraction, and it becomes an important question whether these lines represent cell-walls, rows of dots, &c. When they arise from diffraction, they vary in number according to the obliquity of the incident light and the angular aperture of the object-glass; and when the condenser is used, they vary according to its adjustment, and at a particular adjustment they will sometimes disappear entirely. Hence in these cases the condenser should always be used, and the results obtained controlled by the effects of immersion in highly refractive liquids, and the means mentioned below.

s. A very ingenious method has been proposed and adopted successfully by Mr. Wenham, for exhibiting the form of certain very minute markings upon objects. A negative photographic impression of the object is first taken on collodion in the ordinary way, with the highest power of the microscope that can be used. After this has been properly fixed, it is placed in the sliding frame of an ordinary camera, and the frame-end of the latter adjusted into an opening cut in the shutter of a perfectly dark room. Parallel rays of sunlight are then thrown through the picture by means of a flat piece of looking-glass fixed outside the shutter in such a manner as to catch and reflect the rays through the camera. A screen standing in the room, opposite the lens of the camera, will now receive an image, exactly as from a magic lantern, and the size of the image will be proportionate to the distance. On this screen is placed a sheet of photogenic paper intended to receive the magnified picture.

A portion of a valve magnified in this manner is represented at Pl. 11. fig. 41.

4. *Internal structure.*—We must be understood here as referring to the general structure of an object, *i. e.* whether it is solid or cellular, &c.; and where an object is composed of an aggregation of similar parts, our remarks must be applied to these individually.

The first question arising is whether a transparent object is solid or semisolid and homogeneous, or whether it represents a cell, *i. e.* has an outer membrane or cell-wall and contents of a different nature. When objects possess an outer coat, its two margins are sometimes easily distinguishable on examination by transmitted light, especially when its thickness is considerable. But when the outer coat is thin, these are difficult to distinguish; recourse must then be had to other means than simple inspection; and these will vary according to the nature of the object, and especially the softness of its cell-wall. Sometimes crushing it may show clearly that the contents consist of a liquid with numerous molecules and granules, and that the cell-wall is thin and membranous; for the subsequent addition of water may separate and render both distinct. The most valuable test-method, however, is the production of endosmosis or exosmosis. If we take a cell with a soft and thin wall, and add distilled water to it, it will imbibe a certain quantity of it and become distended, and often the contents will become distinctly separated and visible within;

whilst if a saturated solution of some salt, as chloride of calcium, be added, it will become wrinkled and collapsed. On treating a solid or homogeneous body with water, it remains unaltered, or perhaps swells slightly; but on treating it with the solution of chloride of calcium, no wrinkling or contraction occurs, and its appearance is unchanged. If the outer coat be firm and resisting, the chloride will not cause it to contract and wrinkle.

If there be two coats, the outer being firmer than the inner, the latter will be wrinkled and collapsed, whilst the former retains its shape; this is the ordinary occurrence in young vegetable cells. The exosmotic effects of the chloride of calcium should be looked for soon after its addition to the object, particular care being taken that it comes into contact with the object; for when solid or semisolid bodies are macerated for a long time in the saline solution, they will become contracted, and globules of sarcode will escape from them; but we believe that in all these cases there really exists a cell-wall, or a structure corresponding to it; hence by solid or semisolid bodies, we must be understood to mean those which differ from cells according to the characteristic action of exosmose.

It must be remembered that solution of chloride of calcium is a highly refractive liquid; hence it frequently renders globules so transparent that they are almost or completely invisible, and thus apparently dissolves them; sometimes also it really dissolves them. Moreover, many so-called unicellular vegetable organisms exhibit the contraction of the internal cell-wall or primordial utricle, from long maceration in water only, as is so frequently seen in the Desmidiaceæ "mounted" in water. An aqueous solution of iodine is also frequently useful in bringing to light the existence of an inner cell-wall, especially in vegetable structures, causing it to become wrinkled and collapsed.

Cells have not the tendency to fuse together or adhere to each other, which globules of sarcode or other glutinous solid or semisolid substances have.

If the object be brittle, crushing it will sometimes show its internal structure, by allowing the examination of the margins of the fragments.

Spherical or rounded solid bodies, when immersed in water or other liquids of low refractive power, generally present a much less distinct black margin than cellular bodies, or those with membranous walls.

The determination of the contents of an object furnished with an outer coat, must be made according to the foregoing indications. The contents often consist of liquid in which are suspended molecules and granules. If these exhibit molecular motion, the material in which they are suspended must be liquid. It sometimes becomes a question whether a body enclosed within another is central or lateral. This is readily determined by causing the body to revolve by inclining the stage of the microscope, when, if central and fixed, the enclosed body will retain this position; and if it be less than the cavity of the enclosing structure, positive indication will be afforded that the latter is solid, or at least that it does not consist simply of an outer coat with liquid contents and the enclosed body. But if it be attached to the inner wall of the enclosing structure, the eccentricity of its motion whilst revolving will be evident.

The contents of microscopic bodies are frequently rendered distinct by the addition of reagents, and in some cases can alone be distinguished by their use; thus the nuclei of animal cells are at once made evident by the addition of acetic acid, &c.

The micro-spectroscope is often useful in detecting small quantities of different substances (Spectroscope).

We frequently have to decide whether the interior of an object is solid or tubular. If it consist of a firm substance, drying it, if in liquid, will cause the evaporation of the liquid or other contents, and the entrance of air. A section of it will also show whether it is solid or hollow. The effects of crushing it should also be observed.

B. Histological Analysis.

This consists in the resolution of the object into its component morphological elements, and is usually effected by subjecting it to the action of various chemical reagents, continued maceration, &c. It must never be attempted if inorganic matters be present in quantity, until these have been previously removed. The reagent used should be one which exerts a solvent action upon the substance of which the object is composed, the action being interrupted at a certain stage by the addition of water, &c. In regard to those objects whose morphological elements have become altered by individual growth, &c., histological analysis is of course useless; and the manner in which these have acquired their existing structure, can only be determined by tracing the gradual changes which their morphological constituents undergo, from the earliest period of their existence to that at which they form the object in question. This constitutes the study of development, or it might be termed Histological synthesis. It can rarely be followed directly; but can often be carried out indirectly by examining a number of the objects in all stages of their development, and comparing the changes undergone by their constituents. It requires special care in controlling the identity of the objects.

C. Chemical Reactions.

We cannot too strongly insist upon the necessity of investigating these in the case of all objects submitted to examination, the nature of which is at all doubtful,—and this because in many instances the form or general appearance will afford no criterion by which the nature may be determined. Judgment founded simply upon the form, or upon the mere inspection of an object, therefore, will illustrate the abuse and not the proper use of the microscope. The quantitative and ultimate analysis of substances cannot be made in any manner by the aid of microscopic manipulation; but the qualitative analysis, or the study of the action of chemical reagents upon the object or substance by the aid of the microscope, or the micro-chemical analysis, as the Germans style it (and the term is very convenient), may be undertaken with the prospect of almost certain success, in most cases at least, in ascertaining the proximate chemical composition.

The characteristic reactions or tests for the various proximate principles are given in this work under the respective heads of those substances; and we can here give only a brief sketch of the manner in which the micro-chemical analysis of a substance may be conducted, and without which its microscopic investigation must be imperfect and of little or no value.

The first point to be attended to is, to ensure, as far as possible, the freedom of the object from foreign admixtures. Thus if it should have been found in an animal or vegetable liquid, it must be carefully washed, either in a watch-glass or upon a slide whilst covered with thin glass. The former is readily accomplished: the substance being placed in a watch-glass, water or other solvent of foreign matters is added; the whole is then set aside, to allow of the subsidence of the substance, and the supernatant liquid removed by a pipette. If the body or the particles be very minute, it or they must be placed upon a glass slide, and covered with thin glass; the latter should then be pressed, so far as is possible without crushing the particles, but sufficiently to fix them, and a small piece of coarse white blotting-paper placed upon the upper surface of the slide, so as to touch the edge of the liquid. Capillary attraction will cause the liquid to be absorbed by the paper. Small quantities of water, or other proper solvent, are then added by small portions from the end of a glass rod to the *opposite* edge of the liquid confined by the thin glass. Thus a current will be set up, and the newly added liquid will be absorbed by the blotting-

paper, washing in its course the particles confined between the two glasses. The current will be regulated by the quantity of liquid added, and the facility with which the paper absorbs it.

When the body has been washed, the effects of the various reagents may be examined, by the addition of them in small quantities from the conical stoppers of the test-bottles (see *Test-box*, p. xxiv). The test-liquid being applied to the edge of the liquid in which the body is immersed, gradually mixes with it, and the effects produced may be watched step by step. If a solvent or other action is seen to take place, the result is decisive; but if no action be evident, it must be remembered that the reagent added may not have reached the object under examination, perhaps from an insufficient lapse of time for the occurrence of diffusion in the two liquids. To be positive, therefore, that the reagent has no action upon the object when none is at first apparent, as much as possible of the liquid in which it is immersed should be removed by blotting-paper; or the liquid be gently driven off by evaporation; or, if the object be of sufficient size to ensure its not being lost, the thin glass should be removed, and the whole, or as much as possible, of the liquid removed either by the blotting-paper or evaporation. On then covering the object with the thin glass, and adding the reagent to the edge of the latter, there can be no doubt of its coming into contact with the body; and the result may be considered decisive.

Where the combined effects of a reagent and heat are required to be observed, the former may be added as usual, and the slide placed upon the brass table mentioned at p. xxv until the liquid boils, or the requisite amount of heat has been applied,—the object, of course, being covered by thin glass. The slide must then be allowed to become perfectly cold before being placed under the microscope, otherwise the heat might melt the balsam with which the lenses of the object-glass are cemented together. The cooling is much facilitated by placing the slide upon a plate or surface of metal; we generally use the foot, or a part of the stand, of the microscope for this purpose.

The effect of a red heat is sometimes very desirable to be tested. This may be accomplished by exposing the object, placed upon a strip of platinum foil, a piece of thin glass or of mica, to the flame of a spirit-lamp. The odour evolved should be noticed. If this be ammoniacal, or resemble that of burnt horn, the body, if not crystalline, is probably of animal nature, and certainly contains nitrogen.

If the body consist solely of inorganic matter, or of oxalates, it will not be blackened by the heat. If it consist partly of inorganic and partly of organic matter, it will be blackened, and the inorganic matter will be left in the form of an ash. The alteration produced in the form of the object by the heat should also be noted.

In applying a red heat to substances upon thin glass, the whole of its moisture must first be expelled by evaporation; otherwise the glass will certainly crack, and the experiment be spoiled. The strip of platinum may be held by forceps; and the thin glass or mica, upon a curved piece of iron wire. We can here add only a few of the reagents the action of which it may be most desirable to obtain in determining the nature of a doubtful body. Further particulars will be given under the heads of the various reagents, principles, and tissues, in the body of the work.

1. *Solution of caustic potash* (especially when heated).—The cell-walls of plants are not greatly affected; they retain their primitive form, only becoming somewhat swollen, whilst animal substances are mostly dissolved; chitine, however, is unaltered. The solution also possesses a remarkable power of separating many animal structures into their component cells, &c. When cold, it separates proteine compounds from fatty matters, &c. It also removes the foreign compounds with which the cellulose of the epidermal structures of plants is often imbued.

2. *Solution of iodine* (in water) dyes most animal and vegetable substances brown; renders also lime brown; colours starch, certain cell-walls of vegetables, amyloid, the amylaceous bodies of the human brain, &c. blue.

3. *Sulphuric acid*, when added to the external coat or cell-wall of plants (cellulose) dyed with iodine, renders it blue or purple. In a few instances, however, where cellulose exists in animal tissues, the same blue colour is produced; but in these there is real animal matter also, recognizable by its appropriate tests. When added to bile or proteine compounds mixed with solution of sugar, it renders them red (Pettenkofer's test). If the body contain lime (except already as sulphate), the acicular crystals of the sulphate are produced.

4. *Muriatic acid* with heat colours the proteine compounds.

5. *Acetic acid* brings into view the nuclei of animal cells and tissues, dissolves many salts, &c.

6. *Dilute nitric acid* (20 per cent.) coagulates albumen, renders unstriped muscular fibre-cells very distinct, &c. Strong acid by boiling removes all but the cellulose from woody fibre.

7. *Millon's test-liquid* for proteine compounds. (See MILLON'S TEST.)

8. *Ether* or *benzole* dissolves fatty and resinous matters, &c.

9. *Chromo-sulphuric acid*, or a mixture of solution of bichromate of potash and excess of sulphuric acid, dissolves the intercellular substance of plants, thus isolating beautifully the wood-cells &c., and developes the starch-rings &c.

10. *Ammoniuret of copper*, formed by digesting copper turnings in an open bottle with solution of ammonia, rapidly dissolves cellulose. It must be used fresh.

11. *Dye-tests.*—Carmine and ammonia, or the aniline-compounds (Judson's dyes), are often used as such (DYEING).

These are perhaps the most common reagents which the experimenter will be called upon to use. A general plan for the qualitative analysis of substances must be obtained from works upon chemical analysis. It may be remarked, however, that the qualitative analysis of portions of a substance too minute to be more than barely discerned by the naked eye, may be effected by the aid of the microscope. The use of the microscope in strictly chemical investigations also, cannot be too highly recommended; for it will frequently throw great light upon the distinction of chemical precipitates of closely approximative chemical properties.

D. MEASUREMENT.

A knowledge of the size of objects is of the utmost importance, and is frequently of great assistance in the distinction of one object from another; for many objects of totally dissimilar nature present exactly or nearly the same appearances when examined with different powers. The dimensions should invariably be added to the description of microscopic bodies; and when figures are given, the number expressing the linear amplification of the objects should be placed near them.

Directions for determining the measurement of objects are given under the head MEASUREMENT. It should always be expressed in fractions of an English inch.

In conclusion, we must remark that the observations given in this Introduction are not offered as by any means complete. However, we trust they will serve to show those who have not kept their eyes for many years upon subjects connected with microscopy, that numerous means are at their command for determining the structure of objects, to indicate the nature of these means, and that microscopic researches should be carried out upon something like a definite plan.

The following list of miscellaneous matters, forming an analysis of the second part of the Introduction, may serve to recall to the observer the most important points to be looked for, and the means of discovering them.

MICROSCOPIC ANALYSIS. Form:—*a, outline*; *b, rolling over*; *c, side view*; *d, end view*; *e,* angles, *goniometer.*

Colour:—1, General colour, true colour; 2, pigment; *a,* partial from pigment; *b,* general colour from pigment; 3, iridescence, thin plates; air-bubbles, &c., *immersion in highly refractive liquids, action of transmitted and reflected light*; *compression*; polarization, &c.

Surface:—*Reflected light*; projections; cilia, *margin, iodine, desiccation, fine particles*; hairs, crystals—upon or beneath the surface; tubercles, ridges, folds, *side view*; *effects of altered focus*; *fracture*; *foramina, polariscope*; illusory lines, diffraction; depressions, circular, angular; furrows; tubules; cells; *oblique light, stops in condenser.*

Internal structure and contents:—Homogeneous; cell-wall, *endosmosis, exosmosis, chloride of calcium*; *adherence*; *margin, crushing, molecular motion*; granules, nucleus—central, excentric; *reagents, acetic acid*; *nucleolus,* vacuoles.

HISTOLOGICAL ANALYSIS.—*Reagents*; *maceration, development.*

MICRO-CHEMICAL ANALYSIS.—*Washing*; *heat*; *red heat, odour, ash*; *reagents, contact with reagents*; *potash, ammoniuret of copper, iodine, sulphuric, chromo-sulphuric, muriatic, nitric, acetic acids*; *Millon's test*; *sulphuric acid and syrup*; *sulphuric acid and iodine*; *ether, &c.*; *dyes.*

MEASUREMENT.—In fractions of an English inch (not line nor foreign measures).

BIBLIOGRAPHY.—OPTICS. Herschel, '*Optics,*' *Encyc. Metropolitana*; Brewster, *Optics*; Biot, *Manuel,* &c.; Art. '*Optical Instruments*' in *Natural Philosophy* of the Society for the Diffusion of Useful Knowledge; Lardner, *Natural Philosophy*; Lloyd, *Physical Optics* &c.; Nichol, *Cyclop. of Physical Sciences.*

MICROSCOPES, APPARATUS, and OBSERVATION. Quekett *on the Microscope,* 2nd ed., 1853; Brewster, *Treatise on the Microscope*; Ross, Art. '*Microscope*' in the *Penny Cyclopædia*; Dujardin, *Observateur*; Mandl, *Traité pratique du Microscope,* Paris, 1839; Chevalier, *Traité des Microscopes, &c.,* Paris; Tulk and Henfrey, *Anatomical Manipulation*; Mohl, *Micrographia,* 1846; H. Schacht, *Das Mikroskop* (translated by Currie, 1853); Harting, *Het Mikroskoop* (Dutch, and the German translation, *Das Mikroskop,* 1866); Carpenter, *The Microscope,* 1868; Goring and Pritchard, *Microsc. Cabinet,* 1832; Hannover, *on the Microscope* (transl. by Goodsir), 1853; Heller, *Das dioptrische Mikroskop,* 1856; *Transactions of the Microscopical Society of London*; *Monthly Microscopical Journal*; *Quarterly Journal of Microscopical Science* (passim); Reinicke, *Beiträg. z. Mikroskopie,* 1858; R. Beck, *Treatise on Achromatic Microscopes,* 1865; Frey, *Das Mikroskop, &c.,* 1865; Nägeli u. Schwendener, *Das Mikroskop,* 1867; Reinisch, *Das Mikr. in seiner Bedeutung f. die Erweiterung d. Naturkenntniss,* 1867; Wiesner, *Einleitung &c.,* 1867; Hager, *Das Mikrosk.,* 1869; Dippel, *Das Mik. u. seine Anwendung,* 1867–71; Beale, *The Microscope, &c.*

ERRATA.

Page 14, col. 1, line 16 from top, *for* Pl. 18. fig. 43 *b read* Pl. 19. fig. 17 *b.*

14, col. 1, line 18 ,, ,, *for* Pl. 18. fig. 43 *a read* Pl. 19. fig. 17 *a.*

15, col. 1, last line, *for* Pl. 18. fig. 45 *read* Pl. 19. fig. 16.

153, col. 2, line 12 from top, for *Valvulina* read *Vulvulina.*

153, col. 2, line 40 from top, *after* to *add* foreign chalk and to.

175, col. 1, line 43, *for* CLIO'NA *read* CLI'ONA.

256, col. 2, *for* DISTO'MA *read* DIS'TOMA.

272, col. 1, *for* ENDODRO'MEA *read* ENDODRO'MIA.

275, col. 2, line 2 from bottom, for *Cytheridia* (*Eucythere*) read *Cytheridea, Eucythere.*

320, col. 2, line 39 from top, *for* 1253 *read* 1853.

347, col. 2, line 7, *for* GONIACY'PRIS *read* GONIOCY'PRIS.

371, col. 1, line 16 from top, *after* simple *add* or compound.

397. [*Note.* ILYOBATES has been replaced by KRITHE, G. S. Brady, Pal. Soc. Mon. 1874, p. 184.]

463, col. 1, line 16, *for* Hassall *read* Harvey.

471, col. 1, line 25 from top, *for* Schultze *read* Schulze.

477, col. 1, last line, *add* Teichmann, *D. Saugad.*, 1862.

500, col. 1. MOLLUSCA, Bibl., *add* Huxley, *English Cyclopædia.*

537, col. 2, line 6, *for* KRAUS's *read* KRAUSE's.

537, col. 2, line 25, *for* Clelland *read* Cleland.

575, col. 2, line 33, *for* Hervey *read* Harvey.

644, col. 2, line 2, for *insgnis* read *insignis.*

677, col. 2, *for* SACCAMI'NA *read* SACCAM'MINA.

MICROGRAPHIC DICTIONARY.

ABERRATION.—The deviation of the rays of light from the true focus of a lens or curved mirror, in consequence of which they do not unite at a single point, but form an indistinct or coloured image of an object. It arises from two causes: the form of the lens or mirror, when it is called spherical aberration; and the different refrangibility of the rays of light, when it is called chromatic aberration. See OPTICS.

ABROTHAL'LUS, Notaris and Tulasne.—A genus of Coccocarpeæ (Gymnocarpous Lichens), remarkable for their parasitic habit and the absence of a thallus, so that they are generally destitute of the only characters by which the Lichens, as a class, can be distinguished from the Fungi, namely the presence of gonidia containing chlorophyll; but, according to Lindsay, a sorediiferous degeneration of the apothecia sometimes occurs, when green cell-contents are produced. The genus exhibits three forms of reproductive organs, namely: *asci* with *spores*, contained in *apothecia*; *spermatia* produced in *spermogonia* like those of other Lichens; and besides these, *pycnidia* containing *stylospores*, resembling those of Coniomycetous Fungi. Tulasne describes numerous species, which Lindsay reduces to two, viz.

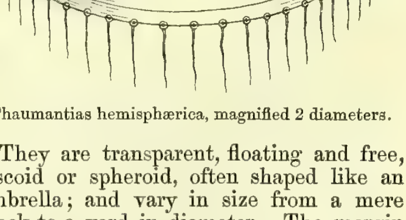
1. *A. Smithii* (including *A. Smithii*, *Welwitzschii* and *microspermus* of Tulasne). Occurring upon furfuraceous thalli of various species of *Parmelia*, and on *Sticta fuliginosa*, in the form of scattered or rarely confluent, *prominent*, *pulviniform* black spots (apothecia), ultimately falling out and leaving little pits. Spermogonia not found; pycnidia abundant, forming minute black spots.

2. *A. oxysporus*. Occurring on furfuraceous states of *Parmelia saxatilis*, mostly associated with *A. Smithii*, on *P. conspersa* and *Cetraria glauca*, in the form of *flattened* or *discoid* brownish-black spots, generally crowded. Spermogonia rare, pycnidia not found.

BIBLIOGRAPHY. Lindsay, *Qu. Micr. Journ.* v. p. 27, and *Brit. Lich.* 311; Tulasne, *Ann. d. Sc. Nat.* 3 sér. Bot. xvii. p. 112, 1852; De Notaris, *Mem. R. Acad. Sc. Turin*, ser. 2. x. p. 351, 1849; Berkeley, *Intr. Cryp. Bot.* 405.

ACALE'PHÆ (Medusæ).—A class in the Animal Kingdom, commonly known as Sea-nettles, on account of their producing urtication when touched; or Jelly-fishes, or Sea-blubbers, from their gelatinous consistence.

Fig. 1.



Thaumantias hemisphærica, magnified 2 diameters.

They are transparent, floating and free, discoid or spheroid, often shaped like an umbrella; and vary in size from a mere speck to a yard in diameter. The margin of the disk is furnished with filiform tentacles, cirri, &c. Their organs are arranged in a radiate manner around a longitudinal

axis, occupied by a central peduncle or stalk, at the bottom of which is the mouth. The disposition of the parts is generally quaternary.

The body is usually composed of a transparent gelatinous substance, closely resembling the vitreous humour of the eye in the Vertebrata.

The *cutaneous surface* of the body is covered with a very delicate epidermis (Pl. 40. fig. 2). Cilia exist on various parts of the body, especially the arms, tentacles, cirri, &c.; upon which also peculiar stinging organs and organs of adhesion occur. In those species which are notorious for their urticating powers, these organs are also situated in aggregations beneath the epidermis of the body. The stinging organs usually form oval capsules, in which a spirally coiled filament is enclosed (Pl. 40. fig. 3 *a, b*); this flies out on the slightest touch, with the capsule to which it is attached, from the irritated part of the skin (Pl. 40. fig. 3 *c*). In some Acalephæ, these stinging organs are replaced by oval capsules from which a rigid bristle projects (Pl. 40. fig. 4). These do not produce urtication, but enable the animal to adhere to other bodies. Near the surface of the body and between the cells composing its substance, pigment-cells frequently occur, some of which are isolated, others aggregated into groups. The paler and more delicate colours are said to arise in some instances from pigment uniformly dissolved in the substance of the body; it is most probable, however, that they arise from iridescence.

A distinct *muscular system* is present, in the form of long, thin, reticular muscular fibres and bundles, almost everywhere pervading the contractile substance of the body.

The floating and locomotion of these animals is often aided by larger or smaller cavities filled with air.

The *nervous system* consists of a ring following the margin of the disk, with ganglionic expansions at intervals, giving off branches to the tentacles and the radial canals. In the Medusæ there are ganglia at the bases of the tentacles.

The *organs of sense* consist of tubercular or spathulate bodies situated near the margin of the body or at the base of the tentacles, and connected with adjoining ganglia. These were regarded as organs of vision; and consist essentially of a membranous capsule containing a clear liquid with crystals of carbonate of lime, and sometimes a red or black pigment (Pl. 40. fig. 5 *g*). But as many of them contain no pigment, these have been considered to be of auditory function, and the crystalline bodies otolithes. Some of them are protected by an overhanging fold of membrane; hence the distinction of naked- and covered-eyed *Medusæ*.

The *digestive cavity*, which is situated in the middle of the body, is lined with ciliated epithelium and furnished with distinct walls, which are directly continuous with the general parenchyma of the body, so that there is no abdominal cavity. The mouth is either single and central, or multiple. In the former case, it is situated at the end of the peduncle, in the middle of the under side, and leads into a stomach, which is frequently furnished with cæcal appendages. When several oral apertures are present, either several œsophageal canals conduct the nutriment through the arms, in which the oral apertures are placed, to a central stomach, or each separate mouth is connected with a distinct tubular stomach. A distinct hepatic organ has not yet been found.

Gastrovascular system. A number of vessels or vessel-like canals run from the stomach or central cavity throughout the body, the principal branches forming rays from the centre to the margin, communicating finally with a circular vessel traversing its circumference (Pl. 40. fig. 5 *d*). These are also lined with cilia, and contain both the food and water. But there is no regular circulation.

A *blood-vessel system* has been described, consisting of a set of closed vessels with very delicate walls, accompanying and enclosing the former vessels, and containing a coloured liquid with coloured globules, representing the blood. But its existence is doubtful.

The Acalephæ are propagated by the formation of ova, and according to the plan of alternation of generations. They are either hermaphrodite or unisexual.

The reproductive organs of the two sexes are often so similar in colour, external form, and arrangement, that they might easily be mistaken for each other, without examination of their contents. They form either utricular or strap-shaped stripes, placed at various parts of the body, often near the rays of the gastrovascular system. In the former case, the spermatic fluid and the ova are evacuated through distinct excretory ducts; in the latter, the spermatozoa and

ova escaping from the strap-shaped testis or ovary, pass directly outwards, or into capacious cavities opening externally by wide orifices. The ova are round, and surrounded by a single very delicate capsule; and the germinal vesicle with its simple germinal spot is visible through the whitish, violet or yellow yolks. The spermatozoa move rapidly in, and are unaffected by water; they are sometimes linear, at others one end is rounded, the other prolonged into a capillary appendage (Pl. 40. fig. 5*).

The developmental metamorphosis of the Acalephæ (*Medusæ*) is very remarkable. When the ordinary process of segmentation of the entire yolk is completed, the ova become converted into ovate infusoria-like embryos (Pl. 40. fig. 6), which revolve upon their longitudinal axis by means of ciliated epidermis, and swim about like species of *Leucophrys* or *Bursaria*. After a time, they become fixed at the anterior extremity to some body; arms then shoot out from the unattached extremity, between which the mouth of the polype-like animal (Hydratuba state) is developed (Pl. 40. figs. 7 & 8). At this stage of development the larvæ multiply by the formation of gemmæ (Pl. 40. fig. 9*a*), and offsets or stolons (Pl. 40. fig. 9*b*); and ultimately each undergoes transverse division, which takes place as follows:—the larvæ grow in length, and the body becomes constricted into several segments (Pl. 40. fig. 10), from each of which eight bipartite processes shoot out in a whorl (Strobila-state). The segments of the body then separate from each other seriatim, from before backwards, swim about with eight rays (Pl. 40. fig. 11), and at last become gradually developed into perfect Medusæ. Many of the Medusæ are phosphorescent, and render the sea luminous.

Gegenbaur divided a *Thaumantias* into a hundred pieces, and found that each piece, provided it contained a portion of the margin of the umbrella, grew into a perfect small *Medusa*.

Some of the organisms, until recently considered species of Acalephæ, are the free reproductive buds of Polypi (Campanulariadæ and Tubulariadæ).

Bibl. Eschscholtz, *System der Acalephen*, Berlin, 1829; Will, *Horæ Tergestinæ, &c.*, 1844; Ehrenberg, *Abhandl. der Berl. Akad.* 1835; Art. *Acalephæ*, Todd's *Cycl.* (R. Jones); Siebold, *Lehr. d. Vergl. Anat.*; Huxley, *Phil. Trans.* 1849; Leuckart, Siebold and Kölliker's *Zeitschrift für Wiss. Zool.* Bd. 3, 1851; Lesson, *Suites à Buffon (Zoophytes Acalèphes)*; Wagner, *Icones Zootomicæ*; Gegenbaur, *Vergl. Anat.* 1870; Gosse, *Marine Zool.*; Forbes, *Monogr. of Nak.-eyed Medusæ* (Ray Soc.); Kölliker, *Icon. Histol.* 1865; Kowalewsky, *Ann. Nat. Hist.* 1867, p. 228.

ACANTHA'CEÆ.—The seeds of many genera of this family are clothed with hairs composed of hygroscopic cells, containing unrollable spiral fibres or detached rings. Among these are *Acanthodium spicatum*, Delile, *Blepharis*, and *Ruellia formosa*. Other species and genera have the hygroscopic cells destitute of internal fibre, as *Ruellia littoralis*, *Phaylopsis glutinosa*, *Barleria noctiflora*, *Lepidagathis*, &c. Further particulars respecting the hygroscopic cells will be found under Cell-membrane and Spiral structures. See also Acanthodium and Ruellia, and for a similar phenomenon in other families, Collomia, Cobæa, Salvia.

Bibl. Kippist, *On the existence of Spiral Cells in the seeds of Acanthaceæ*, *Linnean Transactions*, vol. xix. p. 65.

ACANTHOCYSTIS, Carter.—A genus of Rhizopoda, apparently referable to the Actinophryina.

Char. Rounded, green, with moveable radiating spines and pseudopodia. Body flexible, covered with minute fusiform curved spicula; spines straight, hollow, bifid, discoid at base.

A. turfacea (Pl. 42. fig. 9). Found in heath-bog water; diam. of body $\frac{1}{411}''$.

Bibl. Carter, *Ann. Nat. Hist.* 1863, xii. p. 263.

ACANTHO'DIUM (Flowering Plants, fam. *Acanthaceæ*).—Kippist first described the curious hairs upon the seed of *Acanthodium spicatum*, Delile (Pl. 21. fig. 24). The entire surface of the seed is clothed with hairs of whitish colour, appressed and closely adherent in the dry state, being apparently glued together at their extremities. When placed in water, the hairs are set free and spread out on all sides; they are then seen to consist of clusters of from five to twenty spiral cells firmly coherent below, but free above and separating from the cluster at different heights, expanding in all directions like plumes, and forming a very beautiful microscopic object. The free portions of the cells elongate so as to separate the coils of one, two, or occasionally three internal spiral fibres, which are sometimes branched and not unfrequently broken up into rings; at the lower part of the cells the turns of

the spiral are connected by perpendicular processes so as to convert the spiral into a reticulated structure. See SPIRAL STRUCTURES.

BIBL. *Linnean Transactions,* xix. 65.

ACANTHOME'TRA, Müll. A genus of ACANTHOMETRINA.

ACANTHOME'TRINA.—A family of Radiolarian Rhizopoda.

Char. Body spherical, capsular; traversed by numerous elongate, mostly angular and hollow siliceous spines, which meet in the centre. Between the spines, pseudopodia radiate from the body, as in *Actinophrys* (Pl. 42. fig. 10). Marine.

The body contains yellow globules, and is sometimes covered with small spicules; and it is enveloped by a softer cortical sarcodic mass.

The Acanthometrina, with the Polycystina, have been rearranged by Häckel, in his splendidly illustrated monograph, into 68 genera and 150 species.

They are found recent on the surface and at the bottom of the sea, in the Mediterranean, the Adriatic, and the North Sea.

They form beautiful microscopic objects. See RADIOLARIA.

BIBL. Müller, *Ber. d. Berl. Akad.* 1855, p. 248; id., *Abh. d. Berl. Ak.* 1858, p. 1; Häckel, *Die Radiolarien,* 1862; Claparède and Lachmann, *Etudes s. l. Infus. &c.* 1858, p. 59.

ACA'REA.—A family of Arachnida, belonging to the (3rd) Order *Acarina* (see ARACHNIDA).

These animals are commonly called mites; and every one is familiar with them as occurring in cheese, sugar, flour, &c. Some also occur upon the skin of man and animals, producing the itch and the mange.

The parts of the mouth and the legs, upon which the characters are usually founded, may be best made out by crushing the animals upon a slide with a thin glass cover, and washing away the exuding substance with water, as directed in the Article PREPARATION; sometimes hot solution of potash is requisite, with the subsequent addition of acetic acid and further washing. When afterwards dried, and immersed in Canada balsam, the various parts become beautifully distinct, and may be permanently preserved.

Acarus (*Tyroglyphus*). Body with a transverse furrow between the 2nd and 3rd pairs of legs; legs nearly equal, all perfect, and terminated by a membranous sucker or claws, or both; palpi adherent to the labium (lip).

Trichodactylus. Rostrum (beak) short, with minute bristles; 4th pair of legs longer than the rest, without claws, and terminated by a very long bristle, the rest with 2 claws. (Parasitic.)

Psoroptes. Body soft, depressed, spiny beneath and at the base of the legs; posterior pair of legs small and rudimentary, the rest with a claw and sucker; body terminated by two bristly projections. (Parasitic.)

Sarcoptes. Body soft, transversely wrinkled, and with dorsal papillæ; anterior 2 pairs of legs with suckers, posterior terminated by a long bristle and without suckers. (Parasitic.)

Demodex. Body elongate; cephalothorax distinct from the ringed abdomen; legs terminated by 4 or 5 very minute claws.

ACARI'NA.—An order of ARACHNIDA.

AC'ARUS, Linn.—A genus of Arachnida, of the Order Acarina, and family Acarea (see ARACHNIDA and ACAREA).

The palpi adherent to the labium, the perfect legs, and the transverse furrow distinguish the genus.

Ac. domesticus (Pl. 2. fig. 1), the common Cheese-mite. Body oval, soft, whitish, turgid and furnished with long feathery hairs (*b*). The transverse furrow (*c*) occurs at about the anterior fourth of the body, and another is seen between the head and the part corresponding to the thorax. The head is susceptible of elevation and depression. In its natural state it appears conical (*d*), and is furnished with two large mandibles; these consist of a soft retractile basal joint (*e*), and a second, dilated, non-retractile joint (*f*) resembling the fixed claw of a lobster, and a moveable piece (*f**) working against the latter. The last two pieces are toothed where in contact with each other. These mandibles can be advanced separately or together, and be separated or approximated. When in a state of repose, they form as it were a roof above the labium. The labium (*g*) is quadrilateral, elongated, notched at the end, thin anteriorly and in the middle, and consolidated laterally with the palpi, which are 4 or 5-jointed (*hh*). The legs are reddish, inserted in two separate groups, but not very far distant as in *Sarcoptes.* The anterior pair of legs are remarkable for their size in the male, which is smaller and more active than the female; the third pair are the shortest and smallest; the third joint or femur is larger and longer than those next

it; the sixth joint is long and thin; the seventh joint is furnished with a cordiform membranous caruncle, and a single simple claw or hook; rostrum and legs reddish.

This species is viviparous and oviparous, and the eggs very numerous.

These mites are very abundant upon old cheese, the powder of which entirely consists of them, with their eggs and excrement.

Ac. longior. Body oblongo-ovate. Found upon Gruyère and Dutch cheese (Pl. 2. fig. 2).

Ac. bicaudatus. Abdomen furnished with two pediform tubercles, beneath the base of each of which is a stigma. Found upon the feathers of an ostrich.

Ac. fari'næ. Found in bad flour. DeGeer, *Mém.* vii. p. 97. pl. 15. fig. 15. (*Ac. feculæ*, found by myriads in potatoes. Guérin-Méneville, *Ann. Nat. Hist.* 1867, xix. p. 71.)

Ac. destructor. Resembles *Ac. domesticus*, but legs not reddish, rostrum brown, front end of body broadest; hairs long and dark. It feeds upon the contents of entomological cabinets, especially butterflies. Schrank, *Enum. Ins. Austriæ*, sp. 1057; Lyonet, *Mém. Mus.* xviii. p. 284. pl. 12. fig. 10–12.

There is another *Acarus* which well deserves the name of *destructor*, from its destructive effects upon dried insects; it differs from the *Ac. domesticus* only in having a more strongly marked furrow, in the legs being shorter, and the two foremost pairs being somewhat more widely separated at their origin; the sixth joint is particularly short.

Ac. lactis. Found upon preserved cream. Fabricius, *Spec. Ins.* ii. 490.

Ac. Dysenteriæ. Nyander, *Amœnit. Acad.* v. p. 97; Linn. Gmel. p. 2929. Found in the dejections of dysentery; also in old casks.

Ac. passerinus. Found upon young birds. DeGeer, vol. vii. 139. *Ac. chelopus*, Herm. *Mém. Aptérol.* p. 82. pl. 3. fig. 7.

Ac. passularum. With two very long buccal bristles; it lives upon dried figs, and other saccharine fruits. Hering, *Nova Acta Nat. Curios.* xviii. p. 618, pl. 45. f. 14, 15.

Ac. plumiger, Koch, *Deutschl. Crust., &c.* fasc. 5. pl. 15, is said to have feathery hairs; but this is probably the case in all the Acari, and certainly in many of them (Pl. 2. fig. 1*b*).

Some doubtful species have been formed into new genera, which may find place here.

a. Glyciphagus (Hering). Body soft, not divided into two parts by a transverse line or furrow; legs perfect, with acetabula.

A. (*Gl.*) *prunorum.* Found on dried plums. Hering, *Nova Acta Nat. Curios.* xviii. p. 619. pl. 45. f. 16, 17.

A. (*Gl.*) *hippopodos.* Body as broad as long, very acute anteriorly, entirely covered with short hairs; a minute projection at the end of the abdomen. Found upon the crusts of ulcers on horses' feet. Hering, *Nov. Act. Nat. Curios.* xviii. 607. An undescribed Acarus has also been mentioned as occurring upon the feet of sheep affected with the canker. Grognier, *Zool. vétér.* p. 233.

A. (*Gl.*) *hericius.* Found on weeping ulcers of elms. Robin, *Journ. d. l'Anat.* 1868, p. 603.

A. (*Gl.*) *cursor.* Found in the feathers of the owl and in the cavities of the bones of skeletons. The hairs are jointed. Gervais, *Ann. Sc. Nat.* 2 sér. xv. p. 18. pl. 2. f. 5 *a*.

A. (*Gl.*) (*Sarcoptes*) *palumbinus.* On the pigeon. Koch, *l. c.* fasc. 5. pl. 12; Robertson, *Qu. Micr. Jn.* 1866, p. 201.

Some other species have been insufficiently examined.

Ac. avicularum, DeGeer, *Mém.* vii. 106. pl. 6. fig. 9. Louse of the grouse. Lyonet, *Mém. Mus.* xviii. 281. pl. 15. f. 16.

Ac. marilæ, Gervais, *Dict. Sc. Nat. Suppl.* i. 45.

Ac. favorum. Found in old honeycombs. Herm. *Mém. Aptérol.* p. 86.

Ac. fungi, Herm. *l. c.*

b. Myobia (Heyden). Body elongate, many-lobed; legs perfect, the posterior ones largest. The type of this genus is

A. pediculus musculinus, Schranck, p. 501. pl. 1. f. 5. *Sarcoptes musculinus*, Koch, *Deutsch. Crust. &c.* fasc. 5. pl. 13.

c. Hypopus. See Hypopus.

Bibl. Dugès, *Ann. d. Sc. Nat.* 2 sér. ii. p. 40; Koch, *Deutschl. Crust.*; Walckenaer, *Aptères*, 3 (Gervais); Fumouze and Robin, *Journ. d. l'Anat.* 1867, 505, 561; Boisduval, *L'Entomologie horticole*, p. 76.

ACAULON, C. Müller.—A genus of Phascaceæ (Acrocarpous Mosses), taken as a section of *Phascum* by Wilson. *A. muticum* is common on moist banks.

Bibl. Müller, *Synops. Musc.* i. p. 21; Wilson, *Bryol. Brit.* p. 29.

ACEPHALOCYSTS.—A term used to denote certain simple sacs filled with a transparent liquid, found in the bodies of animals, and usually known as Hydatids by patholo-

gists. They were formerly regarded as distinct parasitic animals; but recent observations show that they often consist of the cysts or larval forms of cestoid Entozoa. The cysts in many cases contain at first only an amorphous substance or a liquid. At a later period their real nature is determined by the presence of the included Echinococcus—head and hooks. The sacs or vesicles are described as oval or somewhat spherical; developing smaller cysts between the laminæ of the parent, which are discharged from its inner or outer surface. They vary in size from a pin's to a child's head. The walls of the sacs vary in thickness and transparence. They present no appearance of either head or body. In the larger cysts the walls are distinctly laminated. They exhibit no fibrous structure, but appear composed of a homogeneous substance closely resembling albumen in properties. Regarding these bodies as animals, two species have been distinguished:—

A. endogena (*socialis* vel *prolifera*), the pill-box hydatid of Hunter. This is met with in the liver, kidney, ovary, testis, and cavity of the abdomen. When developed in the substance of an organ, it is always enveloped by areolar tissue. The secondary cysts are detached from the inner surface of the parent.

A. exogena: in this, the progeny is developed from the outer surface. It is said to be found in the ox and other domestic animals.

In the examination of cysts supposed to be hydatids, careful search should be made for the hooks of *Echinococcus* or *Cysticercus*, which can frequently be found when no further remains of the body are distinguishable. These hooks are figured in Pl. 16. fig. 1*b*. See Entozoa and Echinococcus.

ACERVULINA, Schultze.—Under this name Schultze, in 1854, grouped as a genus some of the adherent varieties of *Planorbulina variabilis*, D'Orb., that have an irregular growth, with *heaped* chambers. They are found in warm seas, attached to algæ and other bodies. The word "acervuline" is applied to any such wildly aggregated growth in Foraminifera.

Bibl. Schultze, *Organism. Polythal.* 67; Carpenter, *Introd. Foram.* 209.

ACETIC ACID. — This is the well-known acid of vinegar.

It occurs in the juice of the flesh of animals; sometimes in the stomach in indigestion; also in the human blood after the use of alcoholic liquids, and in that of animals whose food has been soaked in spirit. It is also a common product of the decomposition of vegetable substances, both by fermentation and in distillation, as well as a component of the natural plants, mostly combined with lime or potash; it is also a rare constituent of some mineral waters.

The only salt of this acid requiring mention is the *acetate of copper* (neutral), which is made by dissolving common verdigris in excess of dilute acetic acid, filtering and crystallizing upon the slides. The crystals, when mounted in Canada balsam, exhibit well the phenomena of dichroism. Pl. 31. fig. 2.

Acetic acid is one of the most common and valuable micro-chemical reagents. It is particularly useful on account of its action upon animal cells in general, rendering the cell-walls transparent and the nuclei more distinct. The ordinary strong acid (sp. gr. 1044) should be used.

ACHARAD'RIA, Wright.—A genus of Hydroida (Polypi).

A. larynx resembles in habit *Tubularia larynx*. Marine; on stones.

Bibl. Str. Wright, *Qu. Mic. Journ.* 1865, iii. p. 50; Hincks, *Brit. Hydr. Zoophyt.* p. 133.

ACHE'TA.—A genus of Orthopterous insects, one species of which, *A. domestica*, the house-cricket, is familiar to every one. The general structure of this insect agrees so closely with that of *Blatta orientalis*, the common cockroach or black beetle, which is described at some length, that it requires no special notice here. (See Blatta.) Some parts of the internal structure of the cricket are very beautiful, as the tongue (Pl. 26. fig. 23), the gizzard (Pl. 27. fig. 1), and the ear in the fore legs (Pl. 27. fig. 7*b*). These, as also the curious mechanism by which the chirping noise of the male is produced, are described under Insects.

ACH'LYA, Nees (*Saprolegnia*, Kützing).—Remarkable microscopic plants, sometimes referred to the Algæ, but more properly belonging to Fungi. Cienkowski has recently confirmed the idea formerly entertained, that *Achlya* is an aquatic form of the Mucorinous Fungus called Sporendonema *Muscæ* (*Empusa Muscæ*, Cohn), the common fly-fungus. Cohn and Al. Braun deny the identity, while Berkeley thinks *Achlya* may be an aquatic form of *Botrytis Bassiana*. They are found growing parasitically upon the bodies of dead flies lying in water, also upon fish, frogs, &c., and in

some cases upon decaying plants. To the naked eye they appear like colourless minutely filamentous tufts adherent to such objects, forming a kind of gelatinous cloud more or less enveloping them. When placed beneath the microscope, the tufts are seen to consist of long, colourless, tubular filaments, spreading out in all directions, with or without lateral branches; these erect filaments arise from a kind of mycelium of ramified filaments lying upon the object upon which the plant grows. The erect filaments are devoid of septa, narrowed upwards, and vary in thickness, being usually of smallest diameter in those cases where they are closely crowded; the ordinary thickness varies from 1-1000 to 1-350 of an inch. The tubes contain a colourless, slightly granular protoplasm, which is denser on the walls; and these sometimes exhibit an irregular spiral arrangement of the granules; the granules are seen to move slowly in anastomosing currents running in various directions, exhibiting, that is, the well-known phenomenon of the circulation of cell-contents, such as is met with in the hairs of *Tradescantia*, &c. The walls of the tubes are coloured blue by iodine and sulphuric acid, therefore consist of cellulose; the contents are nitrogenous, taking a bright yellowish brown with iodine; no trace of starch or of chlorophyll can be detected in the cell-contents in this stage, whence these plants are regarded by some authors as Fungi; but, as mentioned hereafter, Pringsheim states that their ripe spores do contain starch.

Kützing describes a number of species of this genus, under the name of *Saprolegnia*, while a recent observer, Pringsheim, regards them all as forms produced by varying external conditions. A. de Bary separates *Achlya prolifera*, Nees, from *Saprolegnia ferax*, Kützing, referring to the former the *Saprolegnia ferax* of Carus and the *Saprolegnia capitulifera* of Alex. Braun, to the latter the *Achlya prolifera* of Carus, and, doubtfully, the *S. molluscorum* of Nees and Gruithuisen. The distinction between these is said to lie in the details of the formation and emission of the active gonidia or zoospores, but we cannot make out satisfactory differences.

The following details respecting the formation of the active gonidia and the resting spores, are given at length on account of their well illustrating modifications of free-cell formation. In about thirty-six hours after the appearance of a specimen on any body, the apices of the erect filaments exhibit remarkable changes. The granular protoplasm, which at first is equally diffused throughout the tube, only densest where it lies on the wall, increases in quantity and "travels up" into the end of the tube, becoming accumulated there, giving it a brownish colour and at the same time causing its distension, so that the upper part of the tube acquires a clavate form, rounded off above. A sharp line of demarcation is soon formed by the division of the primordial utricle, followed by the production of a septum, which shuts off this clavate joint as the sporange; and a little projecting pouch or beak is developed at the summit, or sometimes a little below this on one side. The contents, becoming still more condensed, again apply themselves as a thick investment on the wall, leaving a lighter space in the middle of the cavity. Inequalities, or nodular protuberances, are soon observable in this layer, and it speedily becomes broken up into numerous little isolated portions, the individualization of these commencing at the summit of the sporange and becoming completed gradually from above downwards. The end-cell is now a clavate sporange filled with numerous polyhedral or globular new "primordial cells," in the development of which from the contents of the general parent-cell no trace of nuclei or "special parent-cells" can be detected; their size is about 1-2700 of an inch, and they have clearly defined outlines, but are still connected together by a gelatinous substance, in which they are completely imbedded. These secondary cells then become retracted from the walls, and accumulate in a dense, rather confused-looking mass in the centre of the sporange; endosmose of water through the now bare cellulose wall of the sporange seems to exert a pressure upon them, and also on the wall itself, which finally bursts at the process or beak mentioned above, and the secondary cells nearest the opening are shot out with some force, the rest following, but gradually more quietly. There is no independent motion of the contents, or jerking of the secondary cells, before this emission of the latter; on the contrary, while in the sporange, they adhere so closely that their shape is scarcely distinguishable, and it is only when the greater portion have escaped, that it is perceived that the pressure had caused them to assume a spindle-shape. As the emission of the secondary cells goes on, those escaping first are only

removed so far as to make room for their successors, and the whole remain adherent together as a globular mass or "capitulum" seated on the apex of the sporange; they reassume, more or less completely, the spherical form, by degrees, after they have escaped from the sporange; those which can expand freely become globular, those pressed upon by their fellows become polyhedral. At the time of emission, these secondary cells exhibit a double line at the circumference, which seems to indicate the thickness of the primordial utricle. Soon after the expulsion another delicate line is detected external to these; and this indicates a newly produced envelope, which becomes thicker with age, and after a certain time can be coloured blue by sulphuric acid and iodine, which demonstrates its composition of cellulose. Application of a strong acid is necessary for this purpose.

The globular head of secondary cells remains for two or three hours attached upon the summit of the empty, colourless sporange. Then these minute cells emit their contents by a lateral orifice, giving origin, each of them, to a zoospore or active gonidium. Neither the motion nor the appearance of the cilia follows the expulsion immediately, but takes place after the gonidia have increased somewhat in size and acquired an ovate form. The duration of the motion lasts from a few seconds to a few minutes, after which the gonidium sinks to rest and begins to germinate. The gonidia possess no cellulose membrane while in motion, but acquire one when they come to rest and germinate. The cilia are two in number, and arise from the point which first emerged from the parent vesicle, and which at all periods exhibited a lighter tint, indicating a vacuole in the protoplasmic mass. If the expulsion of the gonidia is prevented, as occurs sometimes when the plant is kept under the pressure of a glass slide, in too little water, in microscopic investigation of it, the gonidia germinate within their cell-membranes, which, instead of discharging active zoospores, emit germinating prolongations, just like those issuing from the single germinating gonidia. These spread out here in all directions from the globular *capitulum*, still seated on the end of the sporange.

During the formation of these sporanges and the gonidia, after the septum has been completed, the tube sends out lateral branches from just below it, which sometimes equal the sporange in length by the time the latter discharges its contents; then this branch becomes developed as a sporange, either at its summit or in its whole length, or, when the branch is very short, the portion of the main tube below the first septum becomes a sporange. Sporanges of a third rank may succeed to those of the second rank, and so on, until the plant has exhausted the supply of food at its service. In another form the active gonidia are produced at once in the sporanges, without the intervention of secondary cells, and then they begin to move even before leaving the parent sac.

Achlya prolifera also produces, though more rarely, globular or spindle-shaped sporanges, either terminal or borne on special, short, lateral branches, in which are developed resting spores, characterized by a larger size, double cell-membrane, and by the absence of the cilia and consequent motion. The mode of their development is similar to that of the active gonidia, but they are much fewer in number, sometimes as many as twenty, sometimes only four, three, two, or even one being present in a sporange. When a number occur in a spindle-shaped sporange, they are ranged in two rows, alternately, so that each is partially interposed between its two opposite neighbours. Their diameter varies from 1-1250 to 1-750 of an inch, the colour brownish, displaying numerous oil-drops in the granular contents when mature. The sporanges producing them display a number of round orifices when the spores are ripe; but the spores appear to escape by the decay of the walls. These resting spores may remain unchanged in water for a long time when no suitable *nidus* exists, and then will quickly germinate if a dead insect or similar object is thrown in.

The resting spores are from 1 to 20, while the active gonidia are from 5 to 150, the number depending in each case on the size of the sporange, not upon the size of the spores or gonidia, which is tolerably regular. Pringsheim states that starch occurs in the contents of the resting spores of *S. ferax*.

A third form of reproductive organ is described by Cienkowski, which in the earlier stages resembles a sporange of resting spores; but the spores each produce a long tubular neck, which bores through the wall of the sporange and discharges its contents as minute swarming bodies into the water; these have not been seen to germinate.

These flask-shaped bodies resemble the formations seen by Carter in SPIROGYRA, and we have seen them in other Algæ. Al. Braun at first described them as a species of CHYTRIDIUM, but subsequently has expressed an inclination to regard them as *antheridial* spores of *Achlya.*

In addition to the above, Al. Braun has described curled tubular processes, resembling the horns of *Vaucheria,* associated with the sporanges in which resting spores are formed, and he is inclined to regard them as *antheridia* exercising a fecundating office, like the horns of *Vaucheria.* Similar bodies have been recorded in other *Saprolegniæ,* especially in *Achlya cornuta.* (See SAPROLEGNIÆ.)

BIBL. A description of the supposed species will be found in Kützing's *Species Algarum,* p. 159. For further information on the development, see Al. Braun's *Rejuven. in Nature* (*Ray Society,* 1853, pp. 188, 268); Pringsheim, *Nova Acta,* xxiii. pt. 1. p. 397–460, 1851; Anton de Bary, *Botanische Zeitung,* x. p. 473, 1852; Unger, *Linnæa,* 1843, p. 129 (translated in *Ann. des Sc. Nat.* 3me sér. tome ii. p. 5. pl. 1. 1844); Meyen, *Pflanz. physiologie,* iii. 457; Nägeli, *Zeitschrift für Wis. Botanik,* heft 1. p. 102, heft 3, 4, p. 28 (*Ray Society's Reports,* 1845, p. 278, 1849, p. 101); Thuret, *Ann. des Sc. Nat.* 3me sér. t. xiv. p. 20, p. xxii, 1851; Ch. Robin, *Hist. des Végétaux Parasites,* 2nd edit. 1853, p. 372; Varley, *Trans. Microsc. Society,* iii.; Cienkowski, *Bot. Zeit.* xiii. p. 801; Al. Braun, *Ueb. Chytridium, Abhandl. Berlin. Akad.* 1855; *Verjüng. in der Natur,* p. 318 (*Ray Society,* vol. 1853, p. 298). A list of all the writers who had treated of *Achlya* before 1843, is subjoined to Unger's Essay in the *Linnæa*; Pringsheim, *Jahrbücher,* Bd. 1. heft 2, bd. 2. heft 2; Archer, *Qu. Mic. Journ.* 1867, p. 126.

ACHNANTHES, Bory.—A genus of Diatomaceæ (Cohort Achnantheæ).

Char. Frustules compressed; either single, in pairs, or united into a straight filament; geniculate in front view, without septa; attached by a stipes fixed to one angle; uppermost valve with a longitudinal median line, lowermost with a longitudinal line, and a median nodule or stauros.

The individual frustule, when single, or the lowermost when they are united, is furnished with a stipes or stalk, arising from one end of the lower margin. Side view of frustules elliptical, oblong or linear, sometimes slightly constricted in the middle; markings of upper and lower valves different, the upper (Pl. 12. fig. 2) exhibiting transverse rows of dots (appearing like striæ under a low power) interrupted by a longitudinal line, the lower (Pl. 12. fig. 3) being also furnished with transverse rows of dots, interrupted by a stauros, as also by a longitudinal line which in some has a nodule at each end. The valves being much compressed, the transverse rows of dots appear also in the front view. The hoops exhibit faint longitudinal and sometimes transverse striæ.

Achnanthes resembles *Striatella* in its stalked flag-like filaments, but may be known from it by the absence of internal siliceous plates or vittæ.

Four British species:—

Freshwater; markings faint (minute)	*A. exilis**.
Marine or brackish water; markings distinct.	
Stipes longer than frustules	*A. longipes*†.
Stipes shorter than frustules.	
Ends of valves acute	*A. brevipes.*
Ends of valves obtuse	*A. subsessilis.*

* Pl. 12. fig. 4. † Pl. 12. fig. 1.

Kützing enumerates 15 species of *Achnanthes.*

BIBL. Ralfs, *Ann. Nat. Hist.* xiii. 489; Kützing, *Bacill.* p. 75, & *Sp. Alg.* p. 54; Smith, *Brit. Diat.* ii. 25.

ACHNANTHIDIUM, Kütz. A genus of Diatomaceæ (Cohort Achnantheæ).

Char. Those of *Achnanthes,* mostly single, and without the stipes.

Five British species; freshwater:—

Filament of numerous frustules ...	*A. lanceolatum.*
Frustules few, valves constricted in middle	*A. coarctatum.*
Frustules few, often straight, valves constricted near the end............	*A. microcephalum**.
Frustules few, valves obtuse, unconstricted	*A. lineare.*
Frustules few, median line sigmoid	*A. flexellum* †.

* Pl. 12. fig. 5. † Pl. 12. fig. 6.

Frustules very small and markings very faint.

BIBL. Smith, *Brit. Diat.* ii. 30; Kützing, *Bacill.* 75, & *Sp. Alg.* 53.

ACHORION, Link and Remak.—The generic name applied to one of the vegetables occurring in *Favus,* and characteristic of that disease of the skin (also called *Porrigo* or *Tinea favosa*). The structure of the plant, *Achorion Schœnleinii,* bears much resemblance to that of the genus *Torula*; but it occurs in definitely bounded patches having a special arrangement of the microscopic elements of which it is constituted.

Ch. Robin gives a very full history of this plant; but it will suffice to abstract the principal points touching on the microscopic structure, previously to presenting some remarks tending to alter the opinion commonly entertained as to the nature of the so-called *Achorion*. The plant is found upon the human skin, either in the hair-follicles or in depressions of the surface. With regard to the former situation, it appears to be a secondary seat, as it were, since only the "spores" or moniliform filaments composed of rows of "spores" occur therein, adhering firmly to the hair and forming a kind of sheath around it. When it occurs upon the ordinary surface of the skin, it forms a little mass, like a little cup, the *favus*, which is at first developed beneath the epidermis, and laid bare afterwards by desquamation. The *favus* is somewhat hemispherical in general form, and varies from 1-25 to 3-5 of an inch in diameter, its depth or thickness being from 1-25 to 1-6 or 1-5 of an inch. The upper free side is concave, the lower convex, the colour is pale sulphur-yellow, sometimes a little browned by the presence of foreign bodies. The cup-like depression existing at first becomes filled up with advancing growth, and when the *favi* have acquired a considerable size, concentric lines are perceived upon the upper surface. The circumference of the free upper surface adheres to the epidermis, and the mass is generally traversed by one or two hairs, passing completely through it from below. When a vertical section is made of a favus dissected out of its seat, it is found to be composed of the following elements. The periphery consists of a granular crust, about 1-150 of an inch in diameter, the *stroma*, apparently a hardened exudation from the surrounding parts; this is lined by the *mycelium* passing in from it, composed of flexuous, branched, inarticulate filaments, uniform in thickness (at most 1-8000 of an inch). Next the mycelium, proceeding inwards, come the '*sporophores*,' consisting of tubes analogous to those of the *mycelium*, less flexuous, the fertile being more or less straight, terminating in strings of spores. The *spores* are round or oval, the smallest 1-8000 to 1-6000 inch, the largest 1-5000 to 1-4000 inch in diameter, the oval are as much as 1-3500 to 1-2500 in length; the spherical sometimes 1-3500 in diameter. Their membrane is well defined; water and acetic acid do not affect them.

Much has been written by medical authors regarding these bodies; but we shall not enter into this part of the subject here, further than to state that the presence of this vegetable structure seems to be essential and causative in the disease of the skin to which we have alluded. Remak was unable to make any of the spores germinate in or on animal substances; some however emitted prolongations when placed upon an apple, but the surface then decayed and turned brown within the week, and became covered with mildew (*Penicillium glaucum*). One of the entire corpuscles kept upon the arm for several days, fell off without leaving any mark, but a fortnight after a *favus* began to be developed. Gruby states that he inoculated various parts of the body with it, and even caused it to grow upon wood(?). Bennett ultimately confirmed the statements of Gruby as to the inoculation. Other authors are mentioned at the end of this article.

Unfortunately, most authors who have written on the parasitic fungi which occur in morbid conditions of the human frame, or are productive of disease, have not been well acquainted with either Fungi or Algæ. Numberless names have been assigned to them; and in consequence, while many of these organisms have been considered Algæ, they have been regarded by others as Fungi. It is, however, probable that all of them are mere conditions of the most universally diffused species of *Penicillium*, *Aspergillus*, *Mucor*, or *Cladosporium*—genera which are capable of propagation by cells thrown off from the threads, other than the normal fruit. It is quite impossible that, as supposed by Ardsten, such a genus as *Puccinia* could be produced on animal tissues.

Bibl. Ch. Robin, *Végétaux parasites*, Paris, 1853 (with plates, 2nd edit.); Bennett, *Vegetable nature of Tinea favosa* (*Porr. lupinosa* of Bateman), *&c.*, *Monthly Journ. of Medical Sciences*, 1850 (figs.), and *Trans. Roy. Soc. Edinb.* 1842, xv. pp. 227–294; Gruby, *Mém. s. la Teigne, &c.*, *Compt. Rend.* 1841, xiii. p. 72; *Sur les Mycodermes, &c.*, *ibid.*, 309; *Ueber Tinea favosa*, *Müller's Archiv*, 1842, p. 22; Hannover, *Müller's Archiv*, 1842, p. 281–295, pl. 15. figs. 7–9; Müller and Retzius, *Müller's Archiv*, 1842, p. 192, pl. 8 and 9; Lebert, *Physiol. Pathol.* ii. p. 477, Paris, 1845; Remak, *Diagnost. und Pathogen. Unters.* Berlin, 1845, p. 193–215; Bazin, *Rech. sur les Teignes*, Paris, 1853, 8vo (Plates).

ACHROMATISM.—A term properly signifying freedom from chromatic aber-

ration; but commonly used to denote freedom from both spherical and chromatic aberration.

ACICULARIA, D'Archiac.—One of the *Foraminifera imperforata*, related to *Dactylopora*, and consisting of numerous chambers arranged in close order side by side without intercommunication, and forming minute aciculate cylinders, or narrow tapering plates. Known fossil only in some Tertiary beds of France.

BIBL. Carpenter, *Introd. Foram.* 137.

ACINERIA, Duj.—A genus of Infusoria, of the family Trichodinia.

Char. Body oblong or lanceolate, depressed, the fore part somewhat obliquely recurved like the blade of a sabre; a row of cilia, directed forwards, arising from one side.

Differs from *Trachelius*, Duj., in the arrangement of the cilia and in the anterior curvature; devoid of a mouth, like *Trachelius*, which especially distinguishes the present genus from *Pelecida*. 2 species:

1. *A. incurvata* (Pl. 23. fig. 1); marine, colourless; length 1-590 inch.
2. *A. acuta* (Pl. 23. fig. 2), found in fresh water; length 1-580 inch.

Dujardin figures in the latter species cilia upon both margins, those on one side being directed forwards, and those on the other backwards.

Claparède and Lachm. refer these to *Amphileptus*.

BIBL. Dujardin, *Infus.* p. 402; Clap. and Lachm. *Infus.* &c., p. 356.

ACINETA, Ehr.—A genus of Rhizopoda, belonging to the family *Acinetina*.

Claparède and Lachmann enumerate 8 species.

A. mystacina (Pl. 42. fig. 11). Yellowish brown, rounded, tentacles in two bundles; 1-120 to 1-800. On *Lemna minor*.

A. patula (Pl. 42. fig. 12). Body as if resting on a cup-shaped carapace, variable in form; contains brown granules. On marine Algæ. Norway. Length $\frac{1}{100}''$.

A. tuberosa (Pl. 23. fig. 4). Colourless or yellowish brown, triangular when expanded; tentacles arising from the distal angles only. Salt or brackish waters; 1-100 to 1-410.

A. Lyngbyi, ferrum-equinum and *cylindrica*, are referred by Cl. and Lachm. to *Podophrya*.

A. Notonectæ. On the hairs of the legs of *N. glauca*.

BIBL. Pineau, *Ann d. Sc. Nat.* 3 sér. Zool. iii. and ix.; Ehr. *Inf.*; Duj. *Inf.*; Claparède and Lachmann, *Etudes, &c.*; *Ann. N. H.* 1857, xix.; Stein, *Infus.*

ACINETINA, Ehr.—A family of Radiolarian Rhizopoda.

Char. Those of the Actinophryina, but with usually capitate and suctorial tentacles; the body being more or less enclosed in a carapace, which is generally prolonged to form a stalk.

The structure and relations of these animals are still very unsettled. The researches of Pineau and Stein tended to render the existence of the species doubtful, by showing that they were stages of development of *Epistylis, Vaginicola, Vorticella*, &c.; but this has since been found to be incorrect. The remarkable suctorial character of the tentacles has not been proved to occur in all the genera and species. Many, however, have been seen to take food voraciously, which is thus effected: when an Infusorium touches the button-like end of the tentacle, it usually remains adherent to it; the end becomes still more dilated so as to constitute a sucking disk, and the ray becomes thicker and shorter; the other rays at the same time making grasping movements, and endeavouring to attach their extremities to the captured prey. A current of chyme-particles is then soon seen running from the captured infusorium into the body of the *Acineta*. The chyme-particles form at first a slender row, but afterwards collect in a drop. The body of the *Acineta* then becomes opaque, from the collection of the drops.

The colourless or coloured ova described by Ehrenberg are partly chyme-particles, partly oil-drop-like globules which make their appearance in the *Acinetæ* after animal food. The ciliated swarm-germs to which they give origin have been traced directly into *Acinetæ*. Fission has been observed in *Acineta mystacina*, not in the others. The genera may be thus divided:

*Tentacles not borne upon a proboscis.
 Tentacles unbranched.
  Stalks simple.
   No shell { A peduncle .... 1. *Podophrya*.
   No shell { No peduncle { free .. 2. *Sphærophrya*.
   No shell { No peduncle { fixed. 3. *Trichophrya*.
   A shell { Peduncle present 4. *Acineta*.
   A shell { Peduncle absent . 5. *Solenophrya*.
  Stalks branched .... 6. *Dendrosoma*.
 Tentacles branched .... 7. *Dendromycetes*.
**Tentacles borne on a long proboscis .... 8. *Ophryodendrion*.

Here belong, perhaps, the genera *Corethria, Ephelota*, and *Zooteira* (Wright); and Alder's animalcules.

ACMOSPORIUM, Corda. See BOTRYTIS.

ACOMIA, Duj.—A genus of Infusoria, of the family Enchelia.

Char. Body oblong-ovate or irregular, colourless or granular, turbid, composed of a glutinous homogeneous substance containing irregular granules, and ciliated only or principally at one end. Dujardin describes eight species, to which Perty adds one.

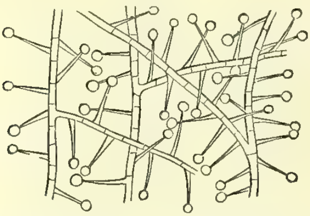
Some are marine, the others inhabiting decomposing infusions. All are minute and colourless.

A. vitrea (Pl. 23. fig. 3), aquatic (freshwater); length 1-868.

BIBL. Duj. *Infus.* p. 382; Perty, *Zur Kenntniss, &c.* p. 149.

ACREMONIUM, Link.—A genus of Hyphomycetous Fungi, belonging to the division Mucedines; distinguished by its jointed threads bearing numerous patent branchlets, each of which is terminated by

Fig. 2.



Acremonium fuscum (magnified).

a single globose spore. Perhaps only states of some other genus. British species:

1. *A. verticillatum,* Link. On dead wood, trunks of trees.
2. *A. alternatum,* Link. On decaying leaves.
3. *A. fuscum,* Schmidt (fig. 1). On dead wood and sticks.
4. *A. ranigenum,* B. and Br. On dead frogs. Distinguished by the threads being matted together below into a distinct stem.

BIBL. *English Flora,* v. pt. 2. p. 347; Greville, *Scott. Cryptogam. Flora,* t. 124. figs. 1 and 2; Berk. and Br. *Ann. Nat. Hist.* 1871, June.

ACROCARPI.—An artificial division of Mosses (see MOSSES).

ACROPERUS.—A genus of Entomostraca, of the family Lynceidæ (Baird).

Char. Shell somewhat harp-shaped, the anterior inferior margin projecting and obtusely angular, inferior antennæ long; beak blunt, very slightly curved downwards; shell striated with longitudinal ribs directed obliquely downwards and forwards; colourless. 2 species:—

1. *A. harpæ* (Pl. 14. fig. 1); each branch of inferior antennæ with 3 long setæ from the extremity of the last joint only.
2. *A. nanus* (Pl. 14. fig. 2), much smaller than the last; anterior branch of inferior antennæ with 4 setæ, one arising from the second, and three from the end of the last joint.

This genus is scarcely distinct from *Camptocercus.*

BIBL. Baird, *Ann. Nat. Hist.* xi. 91; and *Nat. Hist. Brit. Entomos.* 129.

ACROSPERMUM, Tode.—A genus of Sphæronemei (Coniomycetous Fungi), consisting of minute, somewhat cartilaginous perithecia, a few lines high, discharging long, wavy, erect, simple, microscopic spores from a terminal pore or ostiole. British species:—

1. *A. compressum,* Tode. On dry stalks of herbaceous plants.
2. *A. graminum,* Libert. On dead grasses.

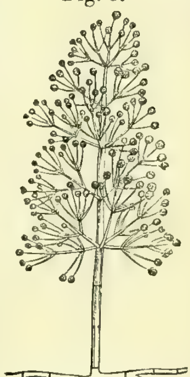
A. cornutum, which is not uncommon on the gills of blackened Agarics, is merely the winter resting-state of *Agaricus tuberosus.*

BIBL. *English Flora,* v. pt. 2. p. 221; *Grev. Sc. Crypt. Flora,* t. 182.

ACROSPORIUM, Nees. — A generic name, formerly applied to certain species of *Oidium* (see OIDIUM).

ACROSTALAGMUS, Corda.—A genus of Mucorini (Physomycetous Fungi), distinguished by its whorled branched septate threads, each branch terminated by a globose vesicle, which is pierced by the tip of the branchlet, from which numerous spores are given off within the vesicle.

Fig. 3.



Acrostalagmus cinnabarinus (highly magnified).

Verticillium lateritium is a form of this beautiful mould with minute naked spores.

The accompanying figure represents *Acrostalagmus cinnabarinus,* Corda. It grows in large patches on rotten potatoes. Hoffmann regards it as a mere form of *Trichothecium roseum,* which is rather a *Dactylium.*

Bibl. Berkeley, *Cryptog. Botany*, p. 294; see also Trichothecium and Verticillium.

ACROSTICHEÆ. — A subfamily of Polypodæous Ferns, with naked sori.

Illustrative genera.

1. *Acrostichum.* Sori seated on all the veins, venules, and parenchyma; veins very much branched, and anastomosing in more or less regular meshes.

2. *Campium.* Sori on all the veins, venules, and the parenchyma; veins very much branched, and anastomosing in more or less regular meshes, with free venules.

3. *Polybotrya.* Sori on all the veins, venules, and the parenchyma; veins pinnate, scarcely anastomosing.

ACROSTICHUM, L.—A genus of Acrosticheæ (Polypodæous Ferns), with naked sori seated on all parts of the leaf. Now broken up into several genera, such as *Platycerium* &c. See Hairs.

ACTINIA. A genus of Anthozoa (Polypes; Zoophytes).

Char. Body conical or cylindrical, adhering by a broad discoidal base; mouth simple, superior, surrounded by one or more uninterrupted series of conical, undivided, tubular tentacula, which are entirely retractile; marine.

Johnston describes 20 British species. They are commonly known as sea-anemones, and are found on the sea-coast adhering to rocks and stones. *A. mesembryanthemum* (1-1½″ diam.), with numerous azure-blue tubercles surrounding the margin of its oral disk, is very common on the British coast.

The body is formed of a thick coat, the inner layer of which consists of longitudinal and transverse muscular fibres. The tentacles are covered with stinging threads and capsules, as in the Acalephæ, often forming beautiful objects. The space between the stomach and the skin is divided into cellular spaces by radiate partitions; the ovaries and the spermatic convoluted tubes being attached to these partitions.

The fibro-areolar tissue, of which the parenchyma of the body consists, is composed of numerous fibres, cells, and intermediate stages, of extreme delicacy (Pl. 33. fig. 1), and somewhat resembling the fibroplastic tissue met with abnormally in the human body. Dispersed throughout it are numerous spindle-shaped, flexible, organic spicula (Pl. 33. figs. 1 *a* and 2), many of them curiously marked by interrupted transverse markings (fig. 2).

In reproductive power they almost equal the Hydræ; when cut across, new tentacles form in a few weeks on the lower half, and each piece becomes a new animal. They are usually propagated by ova, which pass from the ovaries into the stomach, where they are developed. Many of the species exhibit the most splendid iridescent colours.

Bibl. Johnston, *Hist. of British Zoophytes*, 1847; Tugwell, *Man. of Common English Sea-Anemones*; Gosse, *Mar. Zool.* 1, and *"Devonshire Coast;"* Bronn, *Die Klass. &c. d. Thierreichs*; Gegenbaur, *Vergl. Anat.*

ACTINISCUS, Ehrenberg.—A doubtful genus of Diatomaceæ, provided with siliceous shells bearing radiating spines. (Cohort Actinisceæ.)

Char. Individuals microscopic, solid, radiate, resembling a star; marine.

These organisms, which are found both recent and fossil, are ill understood at present. They are especially remarkable for their valves being frequently found perforated. Species:—

1. *A. Tetrasterias*, Ehr. (Pl. 43. fig. 1). Stellate, with 4 free rays; diam. 1-1000″. Virginia.

2. *A. Pentasterias*, Ehr. (Pl. 43. fig. 2). Rays 5; diam. 1-1200″. Recent on the shore of Norway; fossil in the chalk-marl of Greece.

3. *A. quinarius*, Ehr. (Pl. 43. fig. 3). Stellate, rays 5, free; diam. 1-3000″. Ægina.

4. *A. Sirius*, Ehr. (Pl. 41. fig. 45). Rays 6, acute, winged at the base; diam. 1-1200″. Shore of Norway, recent.

5. *A. Discus*, Ehr. (Pl. 43. fig. 4). Disk-shaped, centre smooth, 8 marginal rays not exserted; diam. 1-1200″. Oran.

6. *A. Rota*, Ehr. (Pl. 43. fig. 5). Disk-shaped, centre smooth, 10 marginal rays exserted; diam. 1-1900″. Oran.

7. *A. Lancearius*, Ehr. (Pl. 43. fig. 6). Stellate, with 8 marginal lanceolate rays, and some central shorter on one side; diam. 1-240″. Antarctic Ocean.

Bibl. Ehrenberg, *Leb. Kreidethierchen*, 1840, p. 69; *Monatsbericht*, 1844, p. 76, &c.; Kützing, *Kieselschal. Bacillarien*, 1844, p. 139; *Species Algarum*, 1849, p. 141.

ACTINOCLADIUM, Ehr.—A genus of Mucedines (Hyphomycetous Fungi). No British species yet recorded.

ACTINOCOCCUS, Kützing.—A genus

of exotic Algæ (marine), referred to *Rivularia* by Suhr (Kütz. *Tab. Phyc.* 31. fig. 2).

ACTINOCYCLUS.—A genus of Diatomaceæ (Cohort Coscinodisceæ).

Char. Frustules solitary, free or adherent to other bodies; disk-shaped; valves circular, exhibiting apparently cellular markings, with rays or bands radiating from the centre, which is free from the cellular appearance; no internal septa; marine.

The cellular appearance arises from the existence of depressions upon the surface. The radiant bands arise from undulations of the surface, which are best seen in the front view (Pl. 18. fig. 43*b*).

Only 1 British species, *A. undulatus* (Pl. 18. fig. 43*a*); rays 6, diam. 1-250 to 1-1100''.

Kützing enumerates 34 species; some are found fossil.

Smith admits *A. duodenarius* (rays 12), *A. sedenarius* (rays 16), and *A. octodenarius* (rays 18) as British—species referred by Ehrenberg and Kützing to the genus *Actinoptychus.* These are found in the Medway.

Bibl. Ehrenberg, *Leb. Kreidethierchen*, 1840, p. 57; *Monatsbericht*, 1844, and *Mikrog.*; Kützing, *Kieselschaligen Bacillar.* 1844; *Species Algarum*, 1849; Roper, *Micr. Journ.* ii.; Smith, *Brit. Diat.* i. 25, and ii. 86.

ACTINODISCUS, Grev. A genus of Diatomaceæ.

Char. Frustules free, disk-shaped; valves granular, with a central nucleus, and numerous (15) linear smooth rays extending from it to the margin.

A. Barbadensis (Pl. 44. fig. 22). Diam. 1-250''. In the Barbadoes deposit.

Bibl. Greville, *Micr. Trans.* 1863, 69.

ACTINOGONIUM, Ehr.—A genus of Diatomaceæ.

Char. Prismatic, frustules not forming a filament, subspherical, with 7 or more angles.

A. septenarium (Pl. 43. fig. 8). With 7 angles. Found fossil in Barbadoes earth, with Polycystina.

Not British.

Bibl. Ehr. *Monatsber. d. Berl. Akad.* 1847; *Ann. Nat. Hist.* vol. xx. p. 127.

ACTINONEMA, Fries. See Asteroma.

ACTINOPHRYINA, Duj.—A family of Radiolarian Rhizopoda.

Char. Body usually rounded, contained in a shell or shell-less, giving off radiate non-agglutinating pseudopodia, either from the entire surface, or from parts only; spicules and spines absent.

The genera may be divided thus:—

Shell absent.
  Pseudopodia arising from all parts of the surface .... *Actinophrys.*
    (*Acanthocystis.*)
  Pseudopodia arising from a zone near the circumference .... *Trichodiscus.*
  Pseudopodia arising from one side ... *Plagiophrys.*
Shell present.
  Free.
    Incrusted with foreign matter ...... *Pleurophrys.*
    Not incrusted, oblong.
      Orifice lateral .... *Trinema.*
      Orifice terminal .... *Euglypha.*
  Attached to foreign bodies .... *Urnula.*

Bibl. That of the genera.

ACTINOPHRYS, Ehr.—A genus of Actinophryina.

The species of *Actinophrys* are found in both fresh and salt water. The body exhibits contractile vesicles, mostly near the margin; but sometimes more diffused, and giving it a cellular appearance. Conjugation has been repeatedly observed; but authors are not agreed upon its import. The movement of the pseudopodia is very slow; granules may be seen continually moving in them, as in the Gromida and Foraminifera; but the circulation is much slower, and requires great attention and a high power to render it visible.

A. sol, E. (Pl. 23. fig. 7*b*). Spherical, colourless, whitish tentacles radiating from all parts of the body; 1 or 2 contractile vesicles strongly projecting on the surface; parenchyma not reticular; diam. 1-430 to 1-1200''; aquatic.

A. Eichornii, E. (Pl. 23. fig. 7*a*). As *A. sol*, but parenchyma presenting a more or less regular cellular appearance; diam. 1-100''.

A. marina, D. As *A. sol*, but marine, rather smaller, and movements of tentacles more rapid.

A. brevicirrhis, P. Greenish, not reticular; pseudopodia very short and very numerous.

A. pennipes, Cl. & L. Not reticular; pseudopodia few, slender, and very long; no projecting vesicle.

A. viridis, E. (Pl. 23. fig. 6). Spherical; greenish; rays shorter than the body; diam. 1-280 to 1-620''; aquatic. Perhaps *A. sol* coloured by chlorophyll.

A. digitata, D. Colourless, depressed, tentacles flexible, thickened at base, and when contracted forming finger-like prolongations; diam. 1-770; aquatic.

A. granata, D. Spherical; opaque in

centre; rays taper, shorter than body; aquatic.

A. paradoxa, Carter. With numerous capitate and longer simple tentacles; aquatic. Bombay.

A. oculata, St.=*A. sol?* *A. discus*, D.= *Trichodiscus sol*, E. (Pl. 25. fig. 8). *A. pedicellata*, D.=*Podophrya fixa*, E. *A. stella*, Perty=the eggs of one of the Rotatoria.

The manner in which these animals feed is curious. Any part of the surface of the body may be converted into a temporary stomach. When an infusorium or a minute alga comes into contact with one of the tentacles, it generally becomes adherent. The tentacle with the prey then slowly shortens, and the surrounding tentacles apply themselves upon it, bending their points around the captive, so that it gradually becomes enclosed on all sides. In this way the prey is gradually brought to the surface of the body. The spot at the surface of the body upon which the captured organism is lying slowly retracts, and forms at first a shallow depression, which gradually becomes deeper and deeper, in which the organism is finally lodged. As the depression becomes still deeper, its edges coalesce, and thus a cavity closed on all sides is formed, in which it remains for a certain time and becomes digested. If there be any indigestible residue, a passage for its exit is formed, and it is expelled by further contractions of the substance of the body, and in the same or a different direction from that at which it entered, the canal and the aperture entirely disappearing.

Bibl. Kölliker, *Zeitschr. f. Wissensch. Zoologie*, Bd. i. (*Qt. Micr. Journ.* i.); Stein, *Archiv. f. Naturgeschichte*, 1849; Brightwell, *Fauna Infusoria of Norfolk*; Pritchard, *Infusoria*; Claparède and Lachmann, *Etudes, &c.*; Perty, *Z. Kenntniss &c.*, p. 159; Carter, *Ann. Nat. Hist.* 1864.

ACTINOPTYCHUS, Ehr.—A genus of Diatomaceæ. (Cohort Coscinodisceæ.)

Char. Frustules solitary, free, disk-shaped, with rays and internal radiating septa; valves apparently cellular (areolar), except opposite the rays.

The presence of true internal septa is doubtful; hence it becomes a question whether this genus should not be consolidated with *Actinocyclus*.

Kützing enumerates 16 species, distinguished principally by the number of septa and rays: *A. ternarius*, septa 3; *A. quaternarius*, septa 4; *A. senarius*, rays 6 (Pl. 18. fig. 45), &c. *A. hexapterus*, with 6 thick, solid conical rays, is one of the calcareous corpuscles of an echinoderm; the margin of the disk thick, undulate, and toothed within. Many of the species are fossil.

Bibl. Ehrenberg, *Infus. Abh. d. Berl. Akad.* 1838, and *Berl. Bericht.* 1844; Kützing, *Bacill.* 134; *Sp. Alg.* 130; Greville, *Micr. Trans.* 1866, p. 5.

ACTINOSPHÆRA, Perty.—A doubtful genus of Rhizopoda.

Char. Body minute, spherical, surrounded with irregular, rather rigid processes. Movement that of swimming on various axes.

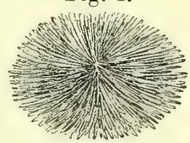
Processes stout and taper. Body colourless, containing greyish-green (food-) spots.

Bibl. Perty, *Zur Kenntniss &c.*, p. 189.

ACTINOSPHÆRIUM=*Actinophrys*, in part.

ACTINOTHYRIUM, Kunze.—A genus of Sphæronemei (Coniomycetous Fungi), forming minute round, flat, black spots, with a central boss of close, radiating, fibrous structure. British species:—

Fig. 4.



Actinothyrium graminis (highly magnified).

A. graminis, Kunze. On leaves and stalks of Grasses in spring (fig. 4). The innate, radiately fibrous, shield-like perithecium finally dissolves at the apex. The stylospores, which are spindle-shaped, are formed beneath the disk, attached by their bases; Fries conjectures that they are transformed asci.

It is probably a state of some *Sphæria* or allied genus.

Bibl. Greville, *Scott. Crypt. Flora*, t. 218.

ACTINURUS.—A genus of Rotatoria, of the family Philodinæa, Ehr.

Char. Eye-spots two, frontal (red); tail-like foot with 2 lateral horny processes and 3 terminal toes. (*Rotifer* with 5 points to the foot.)

Agrees with *Rotifer* in general structure; teeth 2 in each jaw (Pl. 34. fig. 2).

1 species, *A. Neptunius* (Pl. 34. fig. 1). Colourless, body attenuated; length 1-18 to 1-36″. Very common, aquatic.

ADELOSINA, D'Orb.—At first regarded as a generic form, but now recognized as only the young condition of some of the Milioline Imperforate Foraminifera. *Spiroloculina*, *Quinqueloculina*, and *Triloculina*, subgenera of *Miliola*, commence their growth, after the fashion of their congeners also, with a relatively large, subglo-

bose "primordial chamber;" and the succeeding growth produces a curved flask-like chamber, closely enwrapping one side of the former. Until the successive lateral overlappings by new chambers build up the nearly oval outline of the adult *Miliola*, the young shell is one-sided, and may be termed "Adelosina." Found in all seas, and common among Tertiary and Cretaceous fossils at many places.

BIBL. Williamson and Carpenter, *Brit. Foram.*; D'Orbigny, *For. fossiles d. Vienne*, 301.

ADIANTEÆ.—A subfamily of Polypodioideæ (Polypodiæous Ferns).

Illustrative Genera.

Sori on the notches of the fronds.

1. *Lonchitis.* Veins anastomosing; sori linear, semilunate; indusium marginal, semilunar, free within.

2. *Hypolepis.* Veins pinnate; sori subglobose, on the inferior border of the sinuses of the laciniæ or teeth of the frond; indusium marginal, semilunar, free within.

Sori on the margin of the fronds.

3. *Lomaria.* Veins pinnate, forked; fertile fronds narrower; sorus linear, continuous; indusium linear, continuous, free within.

4. *Pteris.* Veins pinnate; sorus continuous; indusium marginal, linear, free within.

5. *Amphiblestra.* Primary veins strong; venules much branched, anastomosing in unequal hexagonal spots; sorus linear, continuous; indusium marginal, linear, free within.

6. *Litobrochia.* Veins anastomosing in hexagonal spots; sorus linear, continuous; indusium marginal, linear, free within.

7. *Allosorus.* Veins pinnate; sori at first roundish and distinct, very soon confluent, and then linear and continuous, covered by the reflexed margin; indusium marginal, linear, continuous, free within.

8. *Cassebeera.* Veins pinnate; sori two under each notched tooth of the leaf; indusium marginal, roundish, covering the pair of sori.

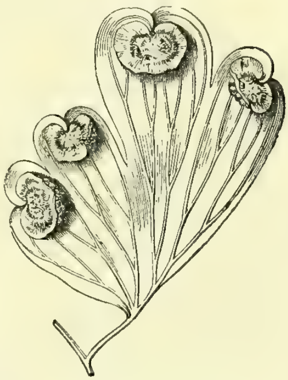
9. *Adiantum.* Veins fan-pinnate; sori linear, indusium linear or semilunar, free within.

10. *Hewardia.* Veins reticulated; sori linear; indusium linear or semilunar, free within.

11. *Cheilanthes.* Veins pinnate; sori subglobose, minute, covered by the reflexed apex of a tooth and the indusium; indusium marginal, scarious, narrow, free within.

ADIANTUM, Linn.—A genus of Adianteæ (Polypodiæous Ferns), with one elegant indigenous, and many exotic species.

Fig. 5.



Adiantum (pinnule with sori covered by indusia); 5 diam.

ADULTERATIONS.—A very important use to which the microscope is applicable, consists in the detection of various adulterations of articles of food, drugs, and products of the arts and manufactures.

The first point in a question of adulteration is, to determine, by microscopic and micro-chemical analysis, the structure and composition of the pure substance; and if the Table given at the end of the Introduction be kept in view in this proceeding, but few points will probably be overlooked. On then comparing these results with those obtained by a similar mode of proceeding in regard to a suspected substance, there will in general be found little difficulty in determining whether it is pure or not. If impurities or adulterating ingredients are present, the next point will be to determine their nature. To do this with certainty, would require that the structure and composition of every kind of substance, either natural or artificial, should be known, which would imply an amount of knowledge possessed by no one. But the question is simplified in practice, because substances used in adulteration must be cheap, and either grown or manufactured in quantities at home, or imported from abroad. Hence they are generally common, and it is pretty well known of what they will probably con-

sist. When the adulteration consists of a chemical substance as it might be called, *i. e.* a salt, metallic oxide, proximate principle, &c., its nature is readily determined by chemical analysis; but when it consists of a vegetable tissue, which has been perhaps subject to a partly chemical process of manufacture, the judgment must be based upon the form of the various parts, their size, relative position, and other particulars holding a place in the Table already alluded to.

The following list of adulterations of articles of general consumption will serve as a guide to the inquirer, and as an index to the special articles in this work in which further details will be found.

Arrow-root.—Cheaper kinds of starch.

Bread.—Mashed potatoes, bean-flour, rice, alum.

Cayenne Pepper.—Ground rice, mustard husks, deal sawdust, mineral colouring-matter of lead and mercury, &c.

Chicory.—Roasted flours of corn and beans, acorns, mangold-wurzel, parsnips, carrots, sawdust, mahogany, burnt sugar, red ochre, &c.

Cinnamon.—Flour of grain and potato, cheap starches, &c.

Cocoa and Chocolate.—Arrow-root and other starches, flours, sugar, chicory, red ochre, &c.

Coffee.—Chicory and its adulterations, as above.

Curry powder.—Flour, ground rice, red lead, red ochre.

Flour.—Meal of other grains, beans, potato-starch, rice.

Ginger.—Flours of various kinds, mustard husks, cayenne pepper, turmeric.

Isinglass.—Gelatine from bones.

Lard.—Potato flour.

Mustard.—Flour, turmeric.

Oat-meal.—Barley-meal.

Pepper and other spices. Flours of grain, peas, potatoes, &c., ground mustard, linseed, &c.

Pickles.—Dilute sulphuric acid (vitriol) instead of vinegar.

Sugar.—Potato flour, starches.

Tea.—Various leaves, catechu, mineral colouring-matters, iron-filings, rice husks.

Tobacco.—Various leaves, paper, &c.

Bibl. Ure, *Dict. of Arts and Manufactures*; Mitchell, *Adult. of Food*; Normandy, *Handbook of Commercial Analysis*; Schacht, *Prüf. d. im Handel vork. Gewebe*, 1853; Wiesner, *Mikroskop, &c.*; Angus Smith, *Rep. of Manchester Sanitary Association*, 1863; Hassall, *Food and its Adult.*, London; *Parliam. Rep. on the Adult. of Food, Drink, and Drugs*, 1855; and *Adult. detected*, 1857; Odling, *Journ. Soc. Arts*, 1858, vi. 318; Garnier and Harell, *Falsificat. d. Subst. Aliment.*; Pereira, *Materia Medica*; Sorby *on Spectroscope, in Qu. Mic. Jn.* 1869, p. 358.

ÆCIDIUM, Persoon.—A genus of Uredinei (Coniomycetous Fungi), consisting of numerous parasitic fungi infesting leaves and herbaceous stems, appearing in their full-grown condition as little cups filled with a reddish or brownish powder (spores), formed by a raising-up and bursting of the epidermis by the parasite developed within. Many may be detected in earlier stages by the deformities they produce in the growing structure of the plants infested, or by pale or reddish spots on the green surface, arising from the presence of the imperfect fungus underneath. These plants are commonly known under the name of blight, brand, &c. Their history has recently received much elucidation at the hands of Tulasne, De Bary and others, and they are found to exhibit a more complicated organization than was formerly imagined. The organs of fructification are produced in two forms, bearing great resemblance to the conditions lately ascertained to exist generally in the Lichens. A brief account of the natural history of certain of the species, derived from De Bary and Tulasne, will give a general idea of the character of this genus.

The nascent *Æcidia* are observed as minute spots upon the herbaceous parts of the plants which they infest. When sections are made of these and placed under the microscope, it is found that the parenchyma of the plant is deformed, irregular, and interrupted by large intercellular passages, among which ramify the filaments of the mycelium of the fungus; these are delicate, much-branched and septate, about 1-3600 of an inch in diameter. At certain points these filaments are crowded and interwoven into hollow globular conceptacles, about 1-180 of an inch in diameter, immediately beneath the epidermis, the interior of which conceptacle is lined with delicate filaments (about 1-12000 of an inch in diameter) arising at all parts and converging towards the centre, except at the upper part, (which is open, and only shut from the external air by the persistent epidermis of the nurse-plant,) where they are directed upwards. A gra-

nular mass occupies the centre of the conceptacle, separating the converging filaments from each other. By the growth of the upper filaments and the increase of the central granular mass, the whole structure increases in size, so as to push the epidermis up above the surrounding surface, finally bursting it, when the upper filaments (*paraphyses*) grow out through the orifice and form a little funnel-shaped tuft on the summit of the protuberance, through the middle of which the granular mass formed below makes its escape. These bodies may be found commonly on the spurges (*Æ. Euphorbiæ*), the barberry (*Æ. Berberidis*), nettles (*Æ. Urticæ*), Compositæ (*Æ. Compositarum*), &c., early in the season; later, they may frequently be recognized in a dried-up condition, being forerunners of the true sporiferous bodies (Pl. 20. fig. 1). The name applied to these organs is *spermogonia*. The filaments converging into the centre of these, termed *sterigmata* (Pl. 20. figs. 2, 3, *s t*), are the important parts of the structure; they terminate in rows of minute bodies of oval form, about 1-6000 of an inch long and 1-12000 in diameter (ibid. *s p.*), which become detached and separated, falling loose into the cavity, where, by a continued growth and shedding of similar bodies from the converging filaments, they accumulate to form the granular mass above spoken of as existing in that situation. The number ultimately becomes enormous, and a gelatinous substance is secreted, glueing them into a mass. When placed in water under the microscope, or when wetted by rain in its natural position, the ripe mass swells and is protruded through the orifice of the spermogonium on the surface of the leaf. By a longer action of moisture the jelly dissolves, and the minute bodies (*spermatia*) spread about in the water, exhibiting "an oscillatory motion, as of a body attached at one extremity." De Bary states that he found iodine arrest this motion, while it persisted for some time in solution of chloride of calcium. No cilia can be detected. Fresh spermatia were coloured bright purple red by sugar and sulphuric acid, but at the same time were so acted on that it could not be made out whether they possessed a membrane free from nitrogenous matter. Solution of potash renders invisible the outlines, not only of the spermatia, but of the sterigmata and paraphyses. The resemblance of these bodies to the spermatia of the Lichens (see LICHENS), is too evident to be mistaken; hence the same terms are applied to the corresponding organs.

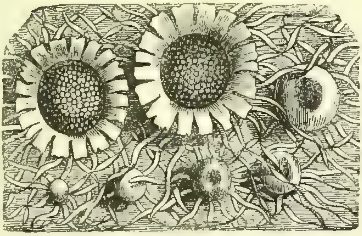
The *spermogonia* occur either in regular groups or scattered just like the *perithecia*; when the latter are on the same surface of a leaf, they often form a circle round the former. Frequently they burst through on opposite sides of a leaf, and then the *spermogonia* are oftenest on the upper, the *perithecia* on the lower face (Pl. 20. fig. 1 *sp*).

After a number of *spermogonia* have been successively developed and discharged their *spermatia*, the *mycelium*, from which they originated, produces a new globular body formed of densely interwoven filaments, usually in the interior of the substance of the leaf or stem, not immediately beneath the epidermis, and ordinarily colourless. Increasing in size in all directions, this globular body, the *perithecium*, soon presents at its base, *i. e.* the point furthest from the nearest epidermal surface, another body composed of very numerous free-ending filaments enclosed in a cellular membrane, which body rapidly grows up within the perithecium, in the direction of the surface of the leaf or stem. The filaments, at first very delicate, are crowded very closely together, and each exhibits in its interior a row of short, colourless, roundish cellules, the uppermost of which is always the largest and the most advanced in development. These cellules are the *spores*, and the filaments in which they are found are the *sporangia* or *thecæ*. The membrane enclosing the *sporangia*, the *peridium* of Persoon, grows *pari passu* with them, and is composed likewise of rows of cells, which stand in a circle around the sporanges, but are firmly connected together side by side by an intercellular substance; this membrane closes in like a bell or vault over the sporanges. By the reciprocal pressure of all parts, the cells of this membrane, at first spherical or ovate, become polygonal. At a certain stage the apex of the perithecium gives way, so that it forms a kind of cup around the membrane enclosing the mass of sporanges arising from the base. The whole structure has by this time come immediately up to the underside of the epidermis, which is next ruptured, and the perithecium and the sporanges are protruded, more or less, according to the habit of the species (Pl. 20. fig. 1 *p, p*). The upper portions of the rows of cells composing the peridial membrane then separate more or less from each other, splitting into lobes, so as

to set the sporanges free, and form a kind of cup with toothed margins seated in the expanded perithecium (figs. 6 & 6 *a*).

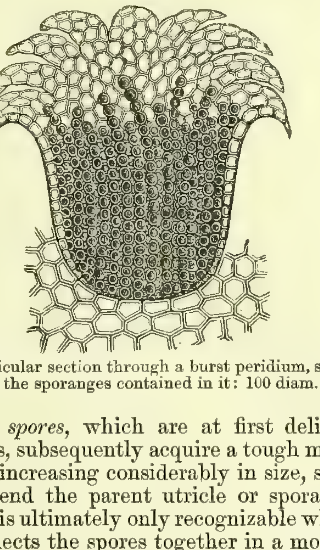
Æcidium Compositarum, Mart.

Fig. 6.



Peridia in various stages of growth on the surface of a leaf: 30 diam.

Fig. 6 *a*.



Perpendicular section through a burst peridium, showing the sporanges contained in it: 100 diam.

The *spores*, which are at first delicate cellules, subsequently acquire a tough membrane, increasing considerably in size, so as to distend the parent utricle or sporange, which is ultimately only recognizable where it connects the spores together in a moniliform series. The spores in most cases now acquire a deeper colour (except in *Æ. leucoconium*), owing to contents chiefly accumulated in the centre. Their membrane is colourless, their form finally irregularly polygonal, and the diameter varies much, even in ripe spores of one and the same species, from 1-1000 to 1-1800 of an inch. The upper spores are often ripe at an epoch when young spores are still in course of production at the lower end of the sporanges; finally, however, the development ceases below and the tube elongates a little beneath the lowest spore, forming a kind of pedicle or *basidium* to the row. The ripe spores either soon fall apart and fill the cup as a loose powder, along with short incomplete sporanges, or the rows persist even after they are mature, held together probably by a firmer sporangial membrane.

The British species of *Æcidium* are numerous; more than thirty are described by Berkeley in the British Flora, many of which are common, especially those of the Mints, the Compositæ, such as the Coltsfoot, &c., the Barberry, the Gooseberry, Buckthorn, Spurge, Nettle, &c. (*Æ. Compositarum*, *Menthæ*, *Berberidis*, *Grossulariæ*, *crassum*, *Euphorbiæ*, *Urticæ*, *&c.*).

There is some reason to believe that *Æcidia* are merely forms of certain *Pucciniæ*, therefore that the notion of the connexion between the Barberry-bush and Mildew is not purely imaginary.

BIBL. For Species:—*British Flora*, ii. pt. 2. p. 369; Greville, *Sc. Crypt. Flora*, pls. 7, 62, 97, 180, 209.

For Anatomy and Physiology:—Unger, *Die Exantheme*, pp. 297, 300, t. 3. f. 18, 19, t. 4; Meyen, *Pflanzenpathologie*, pp. 143, 148–50; Tulasne, *Comptes Rendus*, March 24 and 31, 1851; *Ann. des Sc. Nat.* sér. 3. t. xv.; *ibid.* sér. 3. t. vii. p. 45; sér. 4. t. ii. pp. 126, 173; Léveillé, *Rech. sur le dév. des* Urédinées; *Ann. des Sc. Nat.* sér. 2. t. xi.; Corda, *Icones Fungorum*, iii. t. 3. f. 45; Anton de Bary, *Die Brandpilze*, Berlin, 1853, p. 55 *et seq.* pl. 5, 6 and 7.

ÆGERITA, Persoon.—A genus of Stilbacei (Hyphomycetous Fungi) characterized by short necklace-like threads consisting of irregular spores produced from flexuous, branched, radiating sporophores, forming a subglobose mass. *Æ. candida*, Persoon, grows on damp twigs in marshy places, consisting of scattered white grains about the size of a poppy-seed. *Æ. setosa*, Grev., belongs to the genus *Volutella*.

BIBL. Greville, *Sc. Crypt. Fl.* pl. 268. fig. 1.

ÆGYRIA.—A genus of Infusoria=*Ervilia*, Duj. *Æ. legumen*=*Erv. legumen*, D. Three other species.

BIBL. Claparède and Lachmann, *Infus. &c.* i. p. 288.

ÆNGSTRŒMIA, Br. and Sch.—A genus of Leptotrichaceous Mosses, including many *Dicrana*, and *Ceratodon cylindricus*, Br. & Sch.

BIBL. Müller, *Synops. Musc.* i. p. 426; Wilson, *Bryolog. Brit.* pp. 72, 85.

AËRIAL ROOTS.—A very large proportion of the exotic Orchids are epiphytic plants and produce aërial roots, which absorb moisture from the atmosphere; the same structure occurs in many tropical Araceæ. The surface of these aërial roots is clothed by a peculiar tissue, formed of cells containing a delicate spiral fibre upon the wall (Pl. 39. fig. 6). The strata of spiral-fibrous cells are sometimes numerous, and they cover up the true epidermis of the root. The growing points of such roots are green; but the spiral-fibrous cells soon come to contain nothing but air, and then assume a silvery-white colour.

ÆTEA, Lamx. See ANGUINARIA.

ÆTHA'LIUM, Link. A genus of Myxogastres (Gasteromycetous Fungi). The common *Æthalium*, *Æ. septicum*, L. (*flavum*, Grev.), occurs frequently on tan in hot-houses, where it is very injurious, from the rapidity of its growth and the abundance of its spores. The ordinary form is yellow; but violet and reddish-brown varieties have been met with. It grows also on mosses in woods. Other species of *Æthalium* have been found growing upon iron, lead, or other mineral substances; sometimes a few hours only, after they have been heated, so that the appearance seems quite marvellous. The cream-like matter, of which the part answering to the mycelium or allied production in other Fungi consists, exhibits *Amœba*-like movements.

BIBL. Greville, *Sc. Crypt. Flora*, t. 272; Sowerby's *Fungi*, t. 399. fig. 1 (as *Reticularia hortensis*, Bull.), figs. 3 & 4 (as *R. carnosa* and *R. cerea*); Bolton, *Brit. Fungi*, t. 134 (as *Mucor septicus*, L.); Berkeley, *Crypt. Botany*, pp. 236, 339.

AGARICINI.—An order of Hymenomycetous Fungi, comprising a great portion of the more important esculent species, characterized by an inferior hymenium spread over distinct gill-like processes, which are often easily divisible into two plates. In a few species the interstices of the gills are traversed by veins so as produce the semblance of pores. Amongst the more obscure species of the vast genus *Agaricus*, the hymenium is at first superior, but finally becomes inferior by the turning over of the pileus, which is attached at one point only, or by a very short stem.

The hymenium is composed of vertical cells, called *basidia* by Léveillé, *sporophores* by Berkeley. These bodies are elliptical or elongated cells growing out from the surface of the lamellæ, with four slender stalk-like processes at the upper end, each bearing a single spore, which becomes detached when ripe. These basidiospores are observed by means of cross sections of the lamellæ; the sections must be very thin, and require a high power for satisfactory observation. The sections keep tolerably well put up in chloride of calcium, and are most instructive when taken from a series of specimens of different ages. See AGARICUS, BASIDIOSPORES, and HYMENOMYCETES. The bodies called *cystidia* or *pollinaria*, are globular or oval cells, found associated with the basidia, containing granular matter exhibiting molecular motion when discharged. These organs have been supposed to represent antheridia, but are more probably paraphyses or abortive basidia.

BIBL. Berkeley *on the Fructification of Hymenomyc. Fungi*, *Ann. Nat. Hist.* vol. i. 81; Léveillé, *Sur l'Hymenium des Champignons*, *Ann. des Sc. Nat.* 2 sér. viii. 321; Hoffmann, *Bot. Zeit.* xiv. p. 137 (1856).

AGA'RICUS, Linn.—A genus of Agaricini (Hymenomycetous Fungi). This is one of the largest genera in the Vegetable Kingdom, comprising not only a multitude of European species, but many from tropical climates. As it is of great importance in an alimentary point of view, it seems desirable to give a sketch of the principles on which the species are arranged. Many attempts have been made to divide it into genera, but with little success; and even the subgenera are not always satisfactory.

Undoubtedly, after separating those which are of a dry corky or coriaceous nature with those which in decay run into a sticky liquid, as the genus *Coprinus*, the first grand distinction depends upon the colour of the spores, which are white, rose-coloured, brown, purple brown or black. These characters, however, must be taken with a little latitude; amongst the white-spored species a few will be found where there is a slight pinky or dingy tint, but a very little experience will overcome the slight difficulty; in the rosy-spored series there is little distinction as to colour, but the spores are sometimes quite even in outline, sometimes distinctly angular, a form which very rarely indeed occurs elsewhere. Under the term brown are included various tints as there is a greater admixture of red or yellow.

As regards the two remaining series there is no difficulty.

Another important distinction rests on the circumstance whether the gills are absolutely distinct from the stem, and again whether from an early stage of growth they are truly decurrent; but it is possible to carry the distinction of the decurrence of the gills too far, as in *A. furfuraceus*, which it has been proposed to place in a distinct subgenus; the gills are sometimes decidedly decurrent, sometimes not at all so.

A third important distinction depends on the character of the general envelope, whether more or less distinct. That of the presence or absence of a ring is of less importance, as undoubted examples of *A. melleus* occur in which there is no ring, though every other particular, including the peculiar astringent flavour, accords. For the characters of the subgenera themselves, we may refer to the valuable works of Fries and to Mr. G. W. Smith's 'Clavis,' where, however, it is the opinion of the writer of this article, in which he is borne out by the prince of mycologists, Fries, that some of the subgenera rest on insufficient grounds.

As an article of food the esculent species have been too much neglected, and it is to be regretted that no sufficient analysis has at present been made of the more important species. (M. J. B.)

See Mushroom and Spawn.

AGATE.—The term agate is specially applied by geologists to the crystalloid concretions and geodes of chalcedony—quartz formed in the steam-holes and the fissures of volcanic rocks. It consists, chemically, almost entirely of silica, coloured by metallic oxides. But the principal microscopic interest lies in the so-called moss-agates or Mocha-stones, which are probably highly altered sponge-masses from the chalk and greensand. These, with the flints, have been especially examined by Bowerbank, who supposes them to have originated in the continued attraction and solidification by sponges, of silica dissolved in the water of the ancient ocean,—these sponges formerly existing at the bottom of the sea in as great abundance as their recent types are now found in the ocean, both in tropical and temperate climates. The spicula of sponges are commonly found; also very frequently the fibres, sometimes in a perfect state of preservation, but usually presenting the appearance of having suffered to a great extent from maceration and disruption of their component parts previous to fossilization. Generally the fibres adhere together in confused masses, presenting a moss-like appearance, with here and there one or two in a better state of preservation, and occasionally, near the outer surface of the mass, small portions of the tissue are found quite perfect; in other parts all the intermediate states between perfect preservation and nearly complete decomposition may be observed. The siliceous matter in which these remains are imbedded, usually presents a clear and frequently a crystalline aspect, while the remains of the organized mass are strongly tinted with colours: bright red, brown and ochre-yellow prevail; but occasionally the fibres are milk-white, or bright green. Sometimes the interior of the tubular fibre only is filled with colouring-matter, whilst the sides are semipellucid or of a milky white; in others the whole of the fibres are impregnated with it. Pl. 19. fig. 14 represents sections of a piece of a moss-agate, showing the silicified fibres of sponge *a*, the gemmules *b*, a separate fibre at *c*, and spicula at *d*.

There are two distinct points connected with the presence of these supposed organic remains in agate; one is, whether they really are organic remains, and the other is whether they are related to the formation of the agate, or merely accidentally present. The first point is a very difficult one; we have only the microscopic appearance of the bodies under one set of conditions to judge from: this is always very unsatisfactory; many of the appearances most peculiar to organic bodies, especially when the latter are not connected so as to form a tissue, can be closely imitated by crystallization. Still the mass of evidence is decidedly in favour of the appearances really representing portions of sponges.

The supposed vegetable structures of agates described by Turpin, Müller and many others, have been clearly shown by Göppert to be entirely inorganic products, chiefly dendritic deposits of oxide of iron. His essay contains an elaborate history of the strange notions which have at various times been propounded concerning these objects. Sometimes agate contains crystals of quartz, carbonate of lime, or other mineral matters imbedded in its substance. Those paler varieties of quartz which consist of concentric layers of radiately grouped crystalline needles, frequently polarize light very beautifully; the fortification-agates are common and elegant objects.

Bibl. Bowerbank, *Trans. Geol. Soc.* 1840 (*Ann. Nat. Hist.* vol. vii. 1841; vol. x. p. 9 and 84); Toulmin Smith's objections (but they refer rather to flint), *Ann. Nat. Hist.* vol. xix. p. 1 and 289; Göppert, *On the plant-like bodies enclosed in Chalcedony*, *Ratisbon Flora*, 1848, p. 57. See Flint.

AGATHISTE'GIA, D'Orb.—An order of Foraminifera in D'Orbigny's classification (1825). It may be said to comprise *Cornuspira*, *Miliola* (subgenera, *Uniloculina*, *Biloculina*, *Triloculina*, *Quinqueloculina*, *Spiroloculina*, *Cruciloculina*), *Hauerina*, and *Fabularia*, members of the family *Miliolida* as established by Carpenter. The peculiar ball-of-thread-like folding of the segments, whence the name, is constant in the three last-named genera; but in *Cornuspira* it is merged in a discoidal spire at an early stage of growth.

Bibl. D'Orbigny, *Foram. Cuba*, p. 145; *Foram. Canaries*, p. 140; *Foram. Americ.* p. 68; *For. Foss. Vienn.* p. 255; Williamson, *Rec. Brit. Foram.* p. 78, &c.; Carpenter, *Introd. Foram.* p. 66.

AGLAOPHENIA, Lamx. (Pfr.).—A genus of Polypi, of the family Plumulariadæ. It consists of *Plumularia cristata*, *myriophyllum*, *pennatula* (Johnston). See Plumularia.

Bibl. Hincks, *Brit. Hydroid Zooph.* p. 284.

AGA'VE. See Fibrous Structures.

AG'RION.—A genus of Neuropterous Insects. See Libellulidæ.

AINACTIS, Kützing.—A genus of Oscillatoriaceous plants growing on stones in water. The two known species have been found in Britain.

1. *A. granulifera.* Fronds from 1-12 to 1-2″ in diameter, often confluent, formed of repeatedly dichotomous filaments, dark olive green, containing separate particles of carbonate of lime. *Rivularia granulifera*, Carm. Hassall, *Brit. Fr. Algæ*, lxv. 1. 4; *Ainactis alpina*, Kütz. *Tab. Phyc.* vol. ii. pl. 63. 1.

2. *A. calcarea*, Kütz. Fronds 1-4 to 1-2″ in diameter, orbicular, convex, ultimately confluent, sometimes greenish, often dark chestnut, composed of dichotomous filaments, at length incrusted continuously with carbonate of lime. Kützing, *l. c.* pl. 63. ii.; *Rivularia calcarea*, Carmichael; *Lithonema calcarea*, Hassall, *l. c.* tab. lxv. fig. 2.

Kützing states that the gelatinous sheaths of the filaments of *A. alpina* have a spiral fibrous structure. See Spiral Structures.

AIR.—It need scarcely be remarked that the air consists essentially of a mixture of two gases, oxygen and nitrogen, in the proportion by volume of about 21 parts of the former to 79 of the latter, with variable quantities of gaseous carbonic acid (about 1-2000th) and aqueous vapour. Now as the component molecules of gases are invisible with any powers of the microscope, the air possesses no microscopic characters. In two respects, however, the study of the air in its relations to the microscope is of great importance:—1st, in regard to the optical appearances produced by the passage of light through it when contained in bodies submitted to microscopic examination; and 2ndly, in regard to the particles which are always, in greater or less numbers, suspended in it.

In microscopic investigations we meet with air either existing in cells or cavities in various tissues, or in the form of bubbles, confined by the liquid in which the objects are usually immersed. When surrounded and confined by liquid, it mostly assumes a spherical form, in accordance with the law of hydrostatics, that the pressure of fluids is equal in all directions; sometimes the spherical form is exchanged for that of a compressed or oblong spheroid, the result of the pressure of the glass slip covering the object. When confined in cells or cavities, it assumes the form of these. It is in general easily recognized by transmitted light, from the smooth and even darkness or shading given to its margins, whilst in the centre it appears luminous and clear. Sometimes the dark margins of air-bubbles have a pale purplish-yellow, blue or greenish tinge. By reflected light, of course no darkness is produced, but it then appears vitreous and shining, in consequence of the reflection taking place from its surface. So long as air-bubbles or confined portions of air are large, the optical appearances above described are sufficiently characteristic; although should any doubt exist as to the nature of a supposed accumulation of air, the latter must be displaced, either by pressure between two slips of glass, or by immersing the object in which it exists in some liquid and applying heat. When, however, air is confined within very minute cavities, especially when these possess definite forms, the clear centre is frequently no longer to be detected, the whole appearing perfectly black and solid; and serious errors have arisen from inattention to this circum-

stance, as explained in the Introduction (p. xxxii).

The corpuscles of dried bone were thus formerly considered solid bodies, as their name implies, and as consisting of calcareous matter, until it was found that they could be filled with a liquid. In all cases, then, where absolute certainty is required of the nature of an apparent air-bubble or accumulation of air, attempts should be made to displace the mass, either by pressure or prolonged immersion in a liquid, especially with the aid of gentle heat.

The appearance presented by air contained in tissues, is easily studied in a dry section of any kind of pith or other vegetable structure, such as elder-pith, rice-paper or cork. Cork is really heavier than water, and owes its lightness to the air it contains: see CORK. On immersing these in water, this liquid soon enters the lateral cells, but long digestion is required before the internal cells become filled with it and the whole of the air is displaced. Soaking in alcohol before immersion in water greatly facilitates the displacement of the air.

The determination of the actual nature, as regards chemical composition, of air confined in tissues, is a matter of difficulty where the quantities are microscopic. The nitrogen can only be detected by its negative properties to reagents; the presence of oxygen might be determined by moistening a section of any structure with recently boiled distilled water, and then placing it in a cell containing a solution of protosulphate of iron, and immediately sealing the cell with varnish and allowing the action to continue for some time.

For the detection of CARBONIC ACID, see that article.

There is yet a source of fallacy in the detection of air imprisoned in structures where these are of a hard resisting nature, as in mineral bodies. An illustration of this, with the method of its avoidance, is given under TOPAZ.

In regard to the solid particles present in, or subsiding from the air, and forming dust, these consist principally of the spores of fungi, lichens, and algæ, pollen, the detritus of the soil, fine fragments of vegetable and animal fabrics accidentally separated and diffused during the ordinary operations of every-day life, the dried but not dead bodies of infusoria, and the ova of the lower members of the animal kingdom. The kind of bodies present in the air varies according to the locality; thus in cities, the dust consists mostly of fragments of products of manufactures, with the spores of fungi, mixed with particles of carbon or soot, the ova of the lower animal forms being comparatively few, and belonging to a limited number of species; whilst in open places in the country, a more ready diffusion of the spores of plants and the ova of animals takes place, and the sources from which fragments of textile fabrics are derived, are less numerous.

The inorganic particles deposited from the air, consist of fine grains of sand, wafted from the soil by winds, and rarely fall otherwise than near the currents by which they are borne. They are easily recognized by their angular forms, their resistance to compression, and their not being destroyed or decomposed by exposure to a red heat. Certainty as to their composition can only be obtained by chemical analysis. See SAND.

The animal forms deposited from the air formerly gave rise to much perplexity. It has long been known that when solutions of various organic substances, or liquids containing these matters, undergoing spontaneous decomposition, were exposed to the air, the liquids were soon found to teem with life; infusoria of various kinds, according to the nature of the decomposing matter, being discovered in them in abundance. It seemed very natural to conclude that these derived their origin from the substances undergoing decay; and it is not to be wondered at, that the fact should have given rise to the conclusion that here was evidence of the spontaneous or equivocal generation of animals.

This theory has now ceased to be generally acknowledged; and a common source of fallacious reasoning lies in overlooking the fact, that the air contains the germs of numerous animal forms, still capable of resuming their active vitality when they meet with the requisite conditions. Of this we have convincing proof. For, if the liquid containing the decomposing matters be heated to ebullition for some time in a bottle or other vessel, into the cork closing which two bent tubes are inserted, and, after the air has been completely displaced by the vapour, the fresh air admitted be previously passed through red-hot tubes, which we have no reason to believe exerts any action upon it, animalcules cease to be met with, and the decomposition of the sub-

stance and growth of the organisms no longer take place, even in an indefinite period. That the liquid in these cases does not experience alteration rendering it incapable of supporting the life of the animal forms introduced, is shown by subsequently admitting air which has not been heated to redness, when the animalcules appear as rapidly as in fresh liquids. During the last few years, however, these experiments have been repeated in various ways, and extremely contradictory results have been obtained, into which we cannot enter.

In the infusoria, which are the forms most frequently met with in infusions of decaying substances, and the increase of which takes place in a threefold manner, by subdivision, gemmation, and the formation of swarm-germs and ova, we cannot wonder that the reproductive bodies are frequently not recognizable, when we recollect that the perfect organisms themselves, in many cases, are often barely within the reach of the highest powers of our microscopes.

A list of the animalcules most commonly existing in, or conveyed by the air, will be given under the head of those liquids in which we find them living: see also the articles INFUSIONS, GENERATION (SPONTANEOUS), FERMENTATION, and PUTREFACTION.

Vegetable forms are constantly met with as deposited from the air. In them, the spores are probably alone the bodies by means of which the diffusion of the lower plants by the agency of the air is effected. Minute fungi are frequently found, like the animalcules above alluded to, in various vegetable and animal liquids undergoing fermentation and decomposition. The question of the relation of these fungi to the processes, will be found discussed under FERMENTATION and PUTREFACTION; and the various genera and species found in different kinds of liquids are treated of under the heads of these liquids. Fungi and algæ are also met with as parasites and entophytes upon and in living animals; for an account of these, see PARASITES and ENTOPHYTES.

The lower forms of fungi are frequently found growing upon surfaces from which they can derive no nourishment, as upon slips of glass, window-panes, &c. In these cases they must derive their nourishment from the atmosphere. When found in these situations, however, they soon cease to grow by subdivision of cells or gemmation, but speedily form spores. The most common ones in these situations are the sugar fungus, *Penicillium glaucum* and *Aspergillus penicillatus*, *Mucors*, &c.

The method of distinguishing whether any minute particle deposited from the air is of animal or vegetable nature, is described under TISSUES, ANIMAL and VEGETABLE.

Organic bodies derived from the air are sometimes met with in snow and hail. These are alluded to in the articles SNOW and HAIL.

The air has frequently been examined in regard to the presence of animal or vegetable organisms, which might account for the production of epidemic and infectious diseases. In none of these cases have any bodies ever been found which could in any way be interpreted as the origin of the diseases; nothing more has been met with than common infusoria and such other bodies as may at all times be found in air, from whatever source. As these experiments cannot, however, be too frequently repeated, it may be well to point out the method of making them. The best plan is to connect a glass tube, twice bent at right angles, with an aspirator; the free end of the tube should be drawn to a fine point, and just above this the tube should be blown into a bulb. The point is then immersed in a small quantity of pure water, and the water allowed to run very slowly from the aspirator. The water is then slowly drawn into the tube and the air is washed as it passes by the water in the bulb. When a large quantity of air has been washed by the water, the latter is shaken briskly and allowed to run into a clean glass for examination.

Another method consists in closing, by fusion, the end of a glass funnel, filling this with ice, and collecting the drops of water condensed from the air in a receptacle placed beneath.

Pouchet and Maddox have devised other forms of apparatus for this purpose.

The appearances presented by air as existing in cell-cavities is represented in Pl. 38. fig. 23 *a*; in the delicate cavities of a hair in Pl. 22. fig. 1; and the lower part of the same figure represents a portion from which the air has been displaced by liquid.

BIBL. Pasteur, *Compt. Rendus*, 1860, Sept. 3, p. 348 (*Qu. Micr. Journ.* 1861, p. 118); Pouchet, "*Atmospheric Micrography*," *Compt. Rend.* 1859–60 (*Qu. Micr. Journ.* xviii. pp.

130, 188), and *Nouv. Expér. s. l. gén. spont. &c.* 1863; Maddox, *Month. Micr. Journ.* iii. p. 286.

AIR-BLADDER of Fishes. See SWIMMING BLADDER.

AIR-BUBBLES. See AIR.

AIR-CELLS or sacs of animals.—These are dilatations or expansions of the air-passages; but a distinction must be made between them and the lungs, which might be regarded also as air-cells. See LUNGS.

The proper air-cells or air-sacs, as met with in birds, are membranous cavities communicating with the lungs and distributed through the chest and abdomen. These air-sacs, or prolongations of them, extend over almost all parts of the body, around the joints of the extremities, into the bones, the quills and the feathers, and even between the skin and subjacent muscles. During inspiration, the air enters all these cavities.

In insects the air-cells or sacs consist of dilatations of the tracheæ. See TRACHEÆ.

Their obvious use is either to diminish the specific gravity of the body, or to act as reservoirs of air during the impeded respiration connected with flight.

BIBL. Siebold and Stannius, *Lehrb. d. vergleich. Anat.*; Owen, *Hunterian Lectures*; Carpenter, *Man. of Compar. Anat.*; Gegenbaur, *Vergl. Anat.* p. 822.

AIR-PASSAGES in plants are large intercellular passages, occurring especially in the stems of Monocotyledons and in the leaves and stems of aquatic plants. Their form and arrangement are sometimes very regular and elegant, especially when they depend upon a certain regular peculiarity of shape in the cells which form the walls of the passages. Thus cross sections of the common rush are pleasing microscopic objects, exhibiting regular stellate cells, the rays of which are separated by large air-passages, giving the spongy texture to the structure. Large air-passages, communicating with the stomata, are not unfrequently lined by a cuticular layer similar to that found upon the external surface of epidermal cells. In the *Nymphæaceæ* (Water-lily Order) the large air-passages in the floating leaves and the stem have peculiarly developed star-like cells projecting freely into these cavities; these cells are filled with a granular substance very unlike the contents of the large cells of the general parenchyma of the leaf. Their nature and office are yet unknown. The partitions separating the air-cells horizontally in *Limnocharis Plumieri* and *Alisma plantago* form beautiful microscopic objects. The stems of the *Equiseta*, or Horse-tails, present a very regular arrangement of perpendicular air-passages in the thin walls of their hollow stems, seen well in cross sections. See EQUISETACEÆ.

AIR-SACS in plants.—The genus *Utricularia*, or Bladder-wort, takes its name from a peculiar structure of its leaves. The common species, *U. vulgaris*, L., often found swimming just below the surface of the water, in quiet streams, is provided with a curious floating apparatus, formed by modification of portions of the feathery leaves, consisting of small membranous sacs or pouches, closed by a valve. The opening of the pouch is somewhat funnel-shaped; and the mouth, as also the internal walls of the cavity, is furnished with curious microscopic glandular hairs. Certain of the cells contain a blue colouring-matter distinct in its nature from chlorophyll. The valve of the pouch appears to be capable of opening inwards only; so that while it is turgid with sap, in the vigorous periods of life, it is kept closed by the pressure of the air apparently secreted within the pouch; afterwards the tissue loses its tension and the air makes its way out, allowing water to enter, and thus putting an end to the performance of the function of the air-sac.

BIBL. Meyen, *Secretions-Organe der Pflanzen*, Berlin, 1837, p. 12. t. v. figs. 1–6; Göppert, *Botanische Zeitung*, 1847, p. 721; Benjamin, *Bot. Zeit.* 1848, 1 *et seq.*; Schleiden, *Principles of Botany*, Engl. translation, pp. 77–279.

AIR-TUBES of Insects.—These are horny tubes found in some insects which live in water, as the larvæ of many Diptera and some water-bugs (*Nepa*, *Ranatra*). They are placed either at the first or last abdominal segment. See NEPA, CULEX, INSECTS.

AIR-VESSELS in Insects, see TRACHEÆ. In plants, see SPIRAL STRUCTURES.

ALA'RIA, Greville.—A genus of Laminariaceæ (Fucoid Algæ), distinguished by their superficial fructification, arranged in definite patches on the surface of special fronds, something like the sori of Ferns. The patches consist of sporanges resembling the thecæ of lichens, crowded together and interposed between perpendicular epidermal cells. The sporanges of *A. esculenta* are described by most authors as pyriform *spores* enclosed in a perispore, but they perhaps produce biciliated zoospores like those of *Laminaria*. See LAMINARIA.

BIBL. Harvey, *Brit. Marine Algæ*, p. 29. pl. 3 A; Greville, *Alg. Brit.* p. 25.

ALBERTIA.—A genus of Rotatoria. See ALBERTINA.

ALBERTINA.—A family of Rotatoria (Duj.).

Char. Body cylindrical, vermiform, rounded in front, with an oblique orifice, from which the ciliated organ, scarcely broader than the body, projects, terminated behind by a short conical tail. Jaws forceps-like, simple or unidentate.

This family contains only a single genus, and this a single species, *A. vermiculus* (Pl. 34. fig. 4), which lives parasitically in the intestines of worms (*Lumbrici*) and slugs (*Limaces*). Length 1-47 to 1-79″.

Within the body are seen ova and fœtus in various stages of development. The ciliated apparatus in front of the mouth is surmounted by a hood-like appendage.

ALBU′MEN (Chemical).—A proximate principle of animal and vegetable bodies, with which we are familiar as occurring in the white of egg. It exists in two states, uncoagulated and coagulated. At a temperature of 160° F., provided no free alkali is present, it is reduced from the former into the latter condition. Its chemical relations to other proteine compounds are not very firmly established. It is reddened by Millon's test; is insoluble in acetic acid; is rendered purple by Pettenkofer's test, but the reaction requires some time for its production. In the coagulated state it is distinguished from fibrine by the action of acetic acid, and by its insolubility under prolonged digestion at a heat of 110° F. with solution of nitrate of potash. When heated with strong muriatic acid, it is coloured purple.

Albumen possesses no microscopic characters; when coagulated, it appears to consist of extremely fine amorphous granules. See PROTEINE.

BIBL. See works on Chemistry; Brande's *Chemistry*; Lehmann's *Physiol. Chemie.*

ALBUMEN, or PERISPERM (of seeds).—This is a technical term used in Botany to denote the cellular structure which exists in greater or less quantity in all seeds where the development of the embryo is not accompanied by the entire absorption of the nucleus of the ovule. When the embryo does so displace the nucleus, it becomes immediately invested by the seed-coats; in other cases it is found imbedded in a mass of cellular tissue ef varying structure, which is the 'albumen.' The structure of albumen corresponds to that of the cotyledons of seeds devoid of albumen, both serving the same office, namely that of reservoir of nutriment for the germinating seed. This nutriment may be laid up in different conditions—namely, in the state of starch, oil, aleurone, or of cellulose, and in the last case in a soft and fleshy, or a hard and horny condition. Combined conditions are often met with in the same structure, as when a fleshy tissue contains starch or oil in the cavities of its cells, &c.

Starchy, *mealy* or *farinaceous* albumen constitutes the chief part of the seeds of many plants, especially of those of the Grass-tribe, and is that portion of the corn-grains whence white flour is obtained. Here the cellular tissue is composed of membranous cells densely filled with starch-grains (Pl. 37. fig. 2 *a*). The edible portion of the cocoa-nut is the corresponding region of that seed, and affords us a good example of an oily albumen, composed of tolerably thick-walled cells filled with a viscid mucilage, in which numerous oil-globules are suspended. The stone of the Date, the nut of the Areca Palm (Pl. 38. fig. 21), are good examples of a horny albumen, the cells possessing walls of extreme thickness, traversed by pores and formed, like wood-cells, by the deposition of successive layers. In the ripe seed the structure of this horny albumen is generally much disguised, and a section exhibits the appearance of a homogeneous horny substance excavated into irregular cavities. By applying dilute sulphuric or sulpho-chromic acid, the true boundaries of the cells may generally be distinguished, and often even the lamination of the walls (Pl. 38. fig. 22). The substance called Vegetable Ivory is the albumen of the seed of the *Phytelephas* Palm, and is an instance of an extreme degree of development of the cellulose albumen, vying with the hardest woods in the solidity of its cell-walls. A fine section of this albumen, especially if treated with acid, at once reveals the cellular structure of this dense substance (Pl. 38. fig. 23). The true structure may also be detected by the help of polarized light (see POLARIZATION). The cotyledons of many seeds are, as above stated, formed of elementary structures resembling those of albumen. We find them farinaceous, fleshy, or oily, but rarely attaining to a very great degree of solidity in the horny form. The cotyledons of beans are composed of a fleshy cellular tissue with thick, porous walls, coloured blue by

iodine alone (amyloid), while the cavities of the cells are filled with starch-grains. The cotyledons of the almond, nut, &c. are examples of fleshy cells containing abundance of oil-globules.

The albumen of seeds may be formed by the development of the tissue of the nucleus of the ovule, in which case it is distinguished by some botanists as the *episperm*; generally it is formed from the cells inside the embryo-sac, the latter expanding to displace the nucleus which becomes absorbed; such albumen is called *endosperm*. Some seeds, such as those of the Nymphæaceæ, Piperaceæ and others, have both *endosperm* and *episperm*, *i. e.* albumen formed inside and outside the embryo-sac. The term *perisperm* is often (advantageously) substituted for albumen, which has quite a different signification in physiological chemistry.

The albumen of seeds is examined by means of fine sections. In the horny or bony seeds, the application of solution of potash or nitric acid is very serviceable in ascertaining the true cellular structure.

Bibl. Schleiden and Vögel, *Ueber Albumen*, Nova Acta, 1838, xix. p. 52 (plates).

ALCYONELLA.—A genus of freshwater Polyzoa (Bryozoa), belonging to the order Hippocrepia and family Plumatellidæ.

Char. Tubes branched, adherent to each other by their sides; orifices terminal; ova (statoblasts) presenting an outer ring, but free from spines.

Polypary (polypidom) encrusting, and forming a sponge-like brown or greenish mass, attached to submersed wooden posts, &c. 3 species:—

1. *A. stagnorum* (*fungosa*), Pl. 33. fig. 3. Polypary indefinite; orifices of tubes entire, and without a furrow. Common.

2. *A. Benedeni.* Polypary indefinite; tubes emarginate at the orifice, and furnished with a longitudinal furrow. Rare.

3. *A. flabellum.* Polypary fan-shaped; tubes prostrate, with a furrow. Rare.

Bibl. Johnston, *Brit. Zooph.* p. 391; Allman, *Freshwater Polyzoa* (Ray Society), p. 86; Nitsche, *Müll. Archiv*, 1868.

ALCYONIDIADÆ (Halcyonellea, Ehr., Johnston).—A family of marine Polyzoa (Bryozoa), of the order Infundibulata, and suborder Cyclostomata.

Char. Polypary sponge-like, fleshy, of irregular form; cells irregularly arranged, immersed, with a contractile orifice; no external ovarian capsules. Genera:—

1. *Alcyonidium*, Lamx. Erect; lobed or simple; cells pentagonal.

2. *Cycloum*, Hass. Encrusting, covered with imperforate papillæ; eggs in circular clusters.

3. *Sarcochitum*, Hass. Encrusting, covered with perforate prominences in which the cells are immersed; eggs scattered singly throughout the polypidom.

Bibl. See the Genera.

ALCYONIDIUM, Lamx.—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Ctenostomata, and family Alcyonidiadæ.

Char. Erect, lobed, or simple; cells immersed, pentagonal.

Three British species; they occur attached to marine objects by a narrow base.

1. *A. gelatinosum.* Lobed, lobes subcylindrical, surface smooth; attached by a narrow base. Deep water.

2. *A. hirsutum.* Lobed, compressed, surface papillar from partial protrusion of the polype-cells. Common.

3. *A. parasiticum.* Encrusting, earthy, surface porous.

Bibl. Johnston, *Brit. Zooph.* p. 358; Gosse, *Mar. Zool.* ii.; Hassall, *Ann. Nat. Hist.* vii. p. 370; Reid, *ibid.* xvi. p. 393.

ALCYO'NIUM.—A genus of marine Polypes or Zoophytes, belonging to the order Anthozoa, and family Alcyonidæ.

Char. Polype-mass lobed or encrusting, spongy, containing scattered calcareous spicula. The skin coriaceous, marked with stellate pores; interior gelatinous, netted with tubular fibres and perforated with longitudinal canals terminating in the polype-cells, which are subcutaneous and scattered. Polypes exsertile. Two species:—

1. *A. digitatum* (spicula, Pl. 33. fig. 28). Commonly called 'dead man's toes or hands,' and cows'-paps. Form of polypidom variable, greyish-white or orange-coloured, skin somewhat wrinkled, studded over with stellate pores, even with the surface.

Very common, so that on many parts of the coast scarce a shell or stone can be dredged from the deep that does not serve as a support to one or more specimens.

2. *A. glomeratum.* Colour deep red; rare.

Bibl. Johnston, *Brit. Zoophytes*, p. 174; Gosse, *Mar. Zool.*; Gray, *Ann. Nat. Hist.* 1869, v. p. 117.

ALDERIA.—A name proposed by Pritchard to designate a new and doubtful genus of animals discovered by Alder.

The body of one species (Pl. 40. fig. 14)

consisted of a vase- or cup-form, expanded at the top and furnished with numerous pointed tentacles, abruptly thickened towards the base and forming more than one row. Body attached to a *Sertularia* by a tolerably stout stem.

A second species was rather smaller, the body of an ovate form with a very slender and shortish stem; the tentacles were capitate, not so numerous as in the first species, and placed in a single row round a narrow disk.

This was also found on a *Sertularia*.

A third (Pl. 40. fig. 15) was found in fresh water. Body pear-shaped, or rather bell-shaped, with a distinct rim, and a single row of delicate capitate retractile tentacles; the stem was long and slender. Alder remarks that they come nearest to the genus *Acineta* of Ehrenberg. Similar organisms have been observed by Str. Wright; and they greatly resemble some of Claparède and Lachmann's *Acinetæ*.

Bibl. *Trans. of Tyneside Naturalists' Field Club*, i. p. 365; *Ann. Nat. Hist.* vii. p. 426; Pritchard's *Inf. Anim.* p. 562.

ALECTO, Lamx.—A genus of marine Polyzoa, of the suborder Cyclostomata and family Tubuliporidæ.

The three British species are found upon old shells and stones from deep water.

1. *A. granulata.* Cells in one or occasionally two rows, their walls granular.

2. *A. major.* Cells in more than one or two rows, their walls smooth.

3. *A. dilatans.* Branches of polypary dilated at the ends; cells in several rows, their walls granular.

Bibl. Johnston, *Brit. Zooph.* p. 280; Busk, *Cat. of Mar. Polyz.* (Brit. Mus.).

ALECTORIA, Acharius.—A genus of ParmeliaceousLichens,including two British species, *A. jubata* and *A. sarmentosa*, the fructification of which is rarely met with.

ALEU'RONE (Gluten-flour).—This organized cell-substance, like starch, is very generally diffused through the vegetable kingdom, occurring in most seeds. It exists in large quantity in castor-oil and lupine-seeds, in nuts, almonds, cocoa, and coffee-beans. It was long overlooked, on account of its solubility in water. It consists of minute granules, of a spherical form, often pitted on the surface, either solid or hollow, and covered by a membrane. These are insoluble in ether, alcohol, and fixed oils; but soluble in water, dilute acids, and alkalies. It is coloured deep yellow by iodine, and intense red by carmine-solution. Nitrate of mercury renders the interior brick-red, but does not colour the wall. Each granule consists principally of albuminous matter, but also contains gum and sugar. In many of the grains, as in those of castor-oil seeds, large crystals are met with. Aleurone is usually colourless, sometimes green, as in pistachio-nuts, yellow in Ailanthus-seeds, or blue. It is most easily examined in a thin section of an almond immersed in oil.

The nutritive properties of many seeds (nuts, almonds, &c.) depend to a considerable extent upon the presence of aleurone.

Bibl. Hartig, *Bot. Zeit.* 1857; Wiesner, *Techn. Mikrosk.* p. 74, 1867.

ALGÆ, *Sea-weeds &c.*—This class of the Thallophytes includes the Sea-weeds and the multifarious green vegetable forms of simple cellular structure met with in all streams, ditches, ponds, or even the smallest accumulations of fresh water standing for any length of time in the open air, and commonly on walls or the ground in all permanently damp situations. The great variety of conditions of organization, all variations as it were on the theme of the simple vegetable cell, produced by change of form, number, and arrangement of this simple element, renders the Algæ peculiarly interesting as objects of microscopical research, even in regard to morphological conditions alone.

This simple condition of the structures is here, as in other cases, accompanied by a delegation of the physiological functions most completely and fully to the individual cells; that is to say, the marked difference of purpose seen in the leaves, stamens, seeds, &c. of the flowering plants is absent here, and the structures carrying on the operations of nutrition and those of reproduction are so commingled, conjoined, and, in some cases, identified, that a knowledge of the microscopic anatomy is indispensable even to the roughest conception of the natural history of these plants. Added to this, we find these plants of such simple structure that we can see through and through them while living in a natural condition, and by means of the microscope penetrate to mysteries of organization, either altogether inaccessible, or only to be attained by disturbing and destructive dissection, in the higher forms of vegetation.

This Class comprehends a vast variety of plants, exhibiting a wonderful multiplicity of forms, colours, sizes and degrees of complexity of structure; but the subdivision of them into three groups, characterized by

striking external characters, which are adopted in the classifications of some of the leading Algologists, facilitates the cursory consideration to which we are confined here. These three Orders are the *Red-spored Algæ* (RHODOSPOREÆ or FLORIDEÆ), the *Dark-spored Algæ* (MELANOSPOREÆ or FUCOIDEÆ), and the *Green-spored Algæ* (CHLOROSPOREÆ or CONFERVOIDEÆ), the first two consisting almost exclusively of Sea-weeds, the last of marine and more especially (according to our present knowledge) of fresh-water plants, the majority of which are microscopic when viewed singly.

The Algæ are differently distributed by Thuret, whose researches on their fructification have thrown so much light upon this class. His views are referred to under the Orders.

Order 1. RHODOSPOREÆ or FLORIDEÆ. Almost all marine plants, with a leaf-like or filamentous rose-red or purple, rarely brown-red or greenish red, thallus. Fructification appearing in three forms:—1. *spores*, contained in external or immersed definite masses, mostly enclosed in conceptacles (*ceramidia, coccidia, favellidia, &c.*); 2. *tetraspores*, red or purple, either external or immersed in the frond, rarely contained in proper conceptacles (*stichidia*), each consisting of a transparent membranous sac containing, when ripe, four spores; 3. *antheridia*, pellucid sacs filled with yellow motionless spherical corpuscles (ciliated, Nägeli), collected in masses in situations corresponding to the spore-fruits. According to Bornet and Thuret, the fertilization is effected through the agency of a style-like filiform process or trichogyne, to which the spermatozoids adhere. The trichogyne is either only the prolongation of the cell in which the spores are produced; or, more generally, it is supported upon little cells, which take no direct part in the formation of the spores. See FLORIDEÆ.

Order 2. MELANOSPOREÆ or FUCOIDEÆ. Marine plants with a leaf-like, shrubby, cord-like or filamentous thallus, of olive-green or brown colour. Fructification very varied:—1. in Fucaceæ consisting of monœcious or diœcious conceptacles containing *sporanges* and *antheridia*, the *spores* being fertilized by *spermatozoids* after the discharge of both from the parent; 2. in Laminariaceæ and allied orders consisting of definite or indefinite collections of clavate or filiform *sporanges*, producing *zoospores* which germinate directly; 3. in Cutleriaceæ of similar *sporanges* producing *zoospores*, together with *antheridia*, like those of Fucaceæ; 4. in Dictyotaceæ presenting three forms resembling those of Florideæ, viz. collections of *tetraspores*, of *sporanges* containing simple *spores*, and of *antheridia*. See FUCOIDEÆ.

Order 3. CHLOROSPOREÆ or CONFERVOIDEÆ. Plants growing in sea or fresh water, or on damp surfaces, with a filamentous, or more rarely a leaf-like, pulverulent or gelatinous thallus; the last two forms essentially microscopic, consisting frequently of definitely arranged groups of distinct cells, either of ordinary structure or with their membrane silicified (Diatomaceæ). Fructification varied in its details, but essentially reducible to three forms:—1. *resting spores* produced from the cell-contents after fertilization, either by CONJUGATION or impregnation by (2.) *spermatozoids* produced from the contents of other cells; 3. *zoospores*, 2-, 4-, or multi-ciliated active gonidia, discharged from the vegetative cells without impregnation and germinating directly. The simple *vegetative increase* of the Unicellular forms is a process essentially analogous to the cell-division of the filamentous forms, but results necessarily in multiplication of the species. The Volvocineæ, now included among the Confervoid Algæ, are remarkable for their passing the vegetative stage of existence in the form of ciliated zoospores, mostly collected within a gelatinous common envelope into a definitely arranged family. See CONFERVOIDEÆ.

Excluded families of Algæ:—

CRYPTOCOCCEÆ, Kg., containing the genera *Cryptococcus*, Kg., *Ulvina*, Kg., and *Sphærotilus*, Kg.

LEPTOMITEÆ, Kg., containing the genera *Hygrocrocis*, Ag., *Sirocrocis*, Kg., *Leptomitus*, Ag., *Arthromitus*, Leidy, *Cladophytum*, Leidy, *Mycothamnion*, Kg., *Erebonema*, Römer, *Chamænema*, Kg., *Nematococcus*, Kg., *Chioniphe*, Thienemann, *Moulinea*, Ch. Robin, *Enterobryus*, Leidy, *Eccrina*, Leidy.

PHÆONEMEÆ, containing the genera *Stereonema*, Kg., *Phæonema*, Kg., *Phæosiphonia*, Kg.

All these are byssoid or mucoid products occurring in organic liquids undergoing fermentation, vinous, acetous, or putrefactive, or in solutions of mineral salts, which are likewise decomposed by them. They are probably mycelia of various Fungi and not independent organisms.

BIBL. Harvey, *Man. of British Algæ*, 2nd ed. 1849; *Phycologia Britannica*; C.

Agardh, *Syst. Algarum*; J. Agardh, *Species, Genera et Ordines Algarum*; Kützing, *Phycol. generalis*; *Species Algarum*; *Tabulæ Phycologicæ*; *Phycol. Germanica*; Lyngbye, *Hydrophytologia Danica*; Greville, *Algæ Brit.*; Berkeley, *Cryptogamic Botany*, p. 84; Henfrey, *Elem. Bot.* (Masters), p. 432; Thuret, *Ann. d. Sc. Nat.* 1855; Rabenhorst, *Beit. z. näher. Kenntniss d. Algen*, 1865; id. *Flora Europ. Algarum*, 1865; Bornet and Thuret, *Ann. d. Sc. Nat.* 1867, vii. p. 166 (*Ann. Nat. Hist.* 1867, xix. p. 35).

ALICULARIA, Corda.—A genus of leafy Liverworts (see JUNGERMANNIEÆ), containing one British species, common on hedge-banks.

Fig. 7.

Alicularia scalaris. Immature sporange in the opened perigone (magnified).

A. scalaris = *Jungermannia scalaris*, Schrad., *J. lanceolata*, Eng. Bot. (fig. 7).

Jungerm. compressa, Hook., which has stipules only on the innovations, is included in this genus by Fries and others.

BIBL. Hooker, *British Jungermanniæ*, pl. 61; Sowerby, *Engl. Botany*, pl. 605.

ALKALOIDS.—The utility of the microscope in distinguishing the more common alkaloids from each other, has been shown in an able paper by Dr. Anderson. The characters consist in the crystalline form of the alkaloids, and in that of their sulphocyanides.

The method consisted in dissolving the alkaloids in dilute hydrochloric acid, and mixing the dilute solution, on a glass plate, with solution of ammonia of moderate strength if the alkaloid itself is to be examined, or with a strong solution of the sulphocyanide of potassium if the sulphocyanide is required, and at once placing it under the microscope. The only precaution requisite is to avoid having the solution too concentrated, as the crystals are then less well-defined than if a dilute solution is employed.

The power employed should be 250 diameters; for if a very high power is used, the form of the crystals is not so readily distinguished.

Atropine is precipitated in the amorphous state by ammonia, and not at all by the sulphocyanide of potassium.

Brucia. A salt of brucia in a sufficiently dilute state, mixed with ammonia, does not give an immediate precipitate; but in the course of a very short time, irregular star-like groups of pointed crystals are observed, as in Pl. 7. fig. 1 *a*. Sulphocyanide of potassium produces a precipitate in tufts of extremely thin and feathery crystals, which either radiate from a centre, or present a sheaf-like appearance. The latter form, however, is much better marked in the crystals deposited after some hours from a dilute solution, which are still microscopic, although somewhat larger than those represented in the figure (Pl. 7, fig. 1 *b*).

Cinchonine is obtained by precipitation with ammonia in the form of minute granular masses, made up of more or less distinctly acicular crystals, radiating from a centre. It is, however, somewhat difficult to obtain them well-marked, and they not unfrequently appear as a confused mass of granules, in which the radiated structure is very imperfectly seen. They form best when the solutions are rapidly mixed (Pl. 7. fig. 2). With sulphocyanide of potassium, cinchonine gives a precipitate consisting of six-sided plates, together with a variety of irregular crystalline masses, and a few rectangular plates (Pl. 7. fig. 3). When formed by mixing in a test-tube with agitation, and allowing it to stand for some time, the crystals are still microscopic, but much more definite, and sometimes consist almost entirely of isolated six-sided tables, of great regularity. The precipitate dissolves readily in hot water, and is deposited as the solution cools, in irregular plates.

Narcotine is precipitated by ammonia in branched groups of pointed crystals (Pl. 7. fig. 4). In concentrated solutions a precipitate is thrown down by sulphocyanide of potassium, which dissolves readily in hot water, and is again deposited on cooling. Under the microscope it is perfectly amorphous.

Strychnine. The hydrochlorate, treated with ammonia, gives an immediate precipitate, consisting of minute prismatic crystals, all nearly of the same size and very well defined. Most are isolated, but some cross each other at an angle of about 60°. When lying in one position, they exhibit more or less an appearance of a Saint Andrew's cross, with a peculiar arrangement of their terminal facets (Pl. 7. fig. 5). The sulphocyanide consists of flattened needles, sometimes single, but generally in irregular groups, as in Pl. 7. fig. 6. They are either terminated by a blunt acumination or are truncated. Those precipitated on the large scale present the latter forms.

Morphia. Ammonia does not produce an immediate precipitate in solutions of morphia; but in the course of a longer or shorter period, according to the degree of dilution, crystals form, which gradually increase in size, and possess the form represented in Pl. 7. fig. 7. Salts of morphia are not precipitated by sulphocyanide of potassium, unless the solution is highly concentrated.

Quinine. Its solution gives with ammonia a perfectly amorphous precipitate; with sulphocyanide of potassium it gives small irregular groups of acicular crystals, resembling those produced by strychnia, but longer and more irregular (Pl. 7. fig. 8). When the precipitate is produced in a test-tube, and with a concentrated solution, it falls immediately as a white powder composed of extremely minute needles; but when the solution is dilute, it is deposited after the lapse of twenty-four hours, in crystals from 1-4th to 1-3rd of an inch in length. See QUININE and CRYSTALS.

BIBL. Anderson (T.), *Edinb. Month. Journ.* viii. p. 570.

ALLANTOIN.—A crystalline organic substance found in the liquid of the allantois and in the renal secretion of the calf. As artificially prepared, it is one of the products of oxidation of uric acid.

Its crystals form transparent colourless needles and four-sided prisms, with mostly dihedral unequal summits, Pl. 6. fig. 20. They are not very soluble in either cold or boiling water, are more soluble in alcohol, but not at all in ether.

BIBL. See CHEMISTRY.

ALLANTOIS.—An oblong or pyriform sac developed during a very early period of embryonic life from near the end of the intestine. Its function is that of a temporary respiratory organ. The capillaries in the allantois of the chick are distributed closely like those of the lungs of the Batrachia.

BIBL. Wagner, *Physiology*, translated by Willis; Müller, by Baly; Carpenter, *Hum. Phys.* p. 878.

ALLOMORPHINA, Reuss. — One of Reuss's "Cryptostegian" genera of perforate Foraminifera. It has the appearance of an irregular *Miliola*; but he describes the shell as porous. It is subtriangular, with the chambers in a triple spire, and overlapping so much that only the last three chambers are visible. The aperture is a transverse slit on the inner border of the last chamber. Fossil in the Upper Chalk and Tertiary of Germany.

BIBL. Reuss, *Denks. Akad. Wien*, i. 352; *Sitz. Akad. Wien*, xliv. 372.

ALLOSORUS, Bernh.—A genus of Adianteæ (Polypodioid Ferns). *A.* (*Cryptogramma*) *crispus* is a native of Britain.

ALONA.—A genus of Entomostraca, belonging to the order Cladocera and family Lynceidæ.

The three British species may be thus distinguished:—

1.	Shell reticulated	*reticulata**.
	Shell striated or grooved	2.
2.	Anterior margin of shell nearly straight, shell brown	*quadrangularis*†.
	Anterior margin of shell convex, shell colourless	*ovata*.

* Pl. 14. fig. 4. † Pl. 14. fig. 5.

BIBL. Baird, *British Entomostraca*, p. 131 *et seq.*; pl. 16.

ALSOPHILA, R. Brown.—A genus of Cyatheæous Ferns. Exotic (fig. 8). Almost all the *Alsophilæ* are tree-ferns. Sections of their petioles exhibit fine scalariform ducts, the slits between the fibres forming many perpendicular rows.

Fig. 8.

Alsophila excelsa. Pinnule with sori.

ALTERNARIA, Nees. — A genus of Torulacei (Coniomycetous Fungi). Microscopic filamentous Fungi, remarkable for their flask-shaped, cellular spores, produced in chains which ultimately break up into the single links (fig. 9).

A. tenuis grows parasitically upon other filamentous Fungi, and on decaying gourds; and is common about Berlin, Prague, and other places. Corda made the ripe spores germinate on *Cladosporium herbarum* kept moist. They usually first protruded a filament from the neck, or attenuated projection, and afterwards others from the cells at the sides and opposite end of the spore. These filaments became branched.

Fig. 9.

Alternaria tenuis. Fertile spore-bearing threads (highly magnified).

The Messrs. Tulasne have shown that *Alternaria tenuis* is merely a state of the common *Sphæria herbarum.*

BIBL. Corda, *Icones Fung.* iii. p. 5, pl. 1. fig. 16; *Prachtfl. europäisch. Schimmelbild.* p. 13; Tulasne, *Fungorum Carpologia.*

ALTERNATION OF GENERATIONS. See GENERATIONS.

ALTEUTHA, Baird.—A genus of Entomostraca, of the order Copepoda, and family Cyclopidæ.

One species, *A. depressa* (Pl. 14. fig. 3). Eye red. Found in Berwick Bay, but not common.

BIBL. Baird, *Ann. Nat. Hist.* xvii. p. 416; and *Brit. Entomostr.* p. 216.

AL'TICA. See HALTICA.

ALUCITA.—A genus of Lepidopterous insects, of the family Alucitidæ.

The species are remarkable from having the wings divided into six lobes or rays which are fringed with long narrow scales resembling hairs, giving them a beautiful feathery appearance. They are not uncommon in gardens, and sometimes enter outhouses.

The species of *Pterophorus* exhibit the same structure, excepting that the anterior wings have two, and the posterior three lobes.

BIBL. See INSECTS (Wings).

ALUM.—This well-known substance consists chemically of potash and alumina, with sulphuric acid and water. Its crystals belong to the regular cubic or tesseral system, and usually assume the octahedral form. When dissolved in boiling water with slaked lime, it crystallizes in cubes. The term alum has recently been extended to those compounds in which the potash is replaced by other bases; thus we have soda-alum, chrome-alum, &c. The crystals exert no influence upon polarized light. Common alum possesses but little microscopic interest. Its solution is used in some of the preservative liquids.

ALVEOLINA, D'Orb.—A genus of *Foraminifera imperforata*, of the family Miliolida (Carpenter), nearly allied to *Orbiculina*, but elongated in the direction of the axis; *Orbiculina* being greatly compressed in this direction. *Alveolina rotella* (D'Orb., sp.), however, is nautiloid; *Al. melo*, var. *a*, Ficht. and Moll, is oblately spheroidal; var. *β*, prolately spheroidal; *Al. ovoidea*, D'Orb., elongate-oval; *Al. sabulosa*, Montft., fusiform; and *Al. elongata*, D'Orb., is subcylindrical.

A. fusiformis (pl. 18. fig. 15); *A. rotella* (pl. 18. fig. 16).

BIBL. Carpenter, *Phil. Trans.* 1856, p. 552; *Introd. Foram.* p. 99; Parker and Jones, *Ann. Nat. Hist.* ser. 3. viii. p. 161.

ALYSCUM, Duj.—A genus of Infusoria, of the family Enchelia, Duj.

Al. saltans (Pl. 23. fig. 8). Colourless, with faint longitudinal furrows; movement abruptly jerking; length 1-1260 to 1-1000″.

Found in infusion of hay, and river-water, which have been kept.

Dujardin remarks that it differs from *Enchelys nodulosa*, Duj. (*Pantotrichum Enchelys*, Ehr.), only in the presence of the retractile cilia.

BIBL. Dujardin, *Infus.* p. 391.

ALYSSUM, Linn.—A genus of Cruciferæ (Flowering Plants), possessing elegant stellate hairs. See HAIRS of plants.

AMÆRÆ'CIUM, or AMAROU'CIUM, M.-Edw.—A genus of Mollusca, of the order Tunicata, and family Botryllidæ.

Four British species:—*proliferum* (Pl. 43. fig. 10), *Nordmanni*, *Argus*, and *albicans*.

BIBL. M.-Edwards, *Mém. sur les Ascid. Comp.*; Forbes and Hanley, *Brit. Mollusca*, i. 15; Gosse, *Mar. Zool.* ii. 33.

AMATHIA, Lamx. See SERIALARIA.

AMBER.—This substance, found as a mineral, but strongly resembling in appearance various gum-resins, is the fossil resin of one or more Coniferous trees belonging to a vegetation now extinct. It is found in drops, lamellæ, and stick-shaped pieces, the form and condition depending probably on the mode and situation of its exudation from the trees. In many instances the fragments of amber contain well-preserved remains of the animals and plants which lived at the period of its formation, these having been enclosed by the fluid resin as it escaped from the tree, in a manner which may be exactly compared with our mode of preserving microscopic objects in Canada balsam. Numerous insects, Arachnida, and other animals, with leaves, twigs, fruits, even flowers of plants, have been described and referred satisfactorily to their systematic position; and the aid of the microscope has been largely called in for this purpose, since the elementary structures are in many cases perfectly preserved. The tissue of fragments of Coniferous wood, the stomates of leaves, and glandular and other hairs have been recognized; and besides the larger Cryptogams, Mosses, Jungermanniæ, &c., peculiar microscopic Fungi and Diatomaceæ have been preserved in a perfectly distinct condition.

The structure of the wood of the Amber-fir, *Pinites succinifer*, Göpp., approaches closely that of our *Pinus Abies* and *P. Picea*, differing scarcely in any respect but in the smaller number of the bordered pores, which are of slightly different form.

Two microscopic Fungi preserved in amber have been described and figured by Berkeley:—1. *Penicillium curtipes*; 2. *Brachycladium Thomasinum*, a form approaching *Corethropis* of Corda. A third form, described at the same time as *Streptothrix spiralis*, he now considers to be an appearance produced by enclosed bubbles of air.

Ehrenberg has detected a number of Diatomaceæ in amber, namely, *Amphora gracilis, Cocconeis borealis, Cocconema Cistula, Fragilaria capucina, Navicula affinis, N. Amphioxys, N. Bacillum, Pinnularia capitata,* and *P. Gastrum.*

Bibl. Göppert and Berendt, *Die im Bernstein, &c.,* Berlin, 1845 (*Regensburg Flora,* vol. xxviii. p. 545, 1845); Ehrenberg, *Ber. Berlin. Acad.* 1848, p. 17; Berkeley, *on Moulds detected in Amber, Ann. Nat. Hist.* 2nd ser. vol. ii. p. 380, tab. xi., xii.; Idem. *Crypt. Botany,* p. 303.

AMBLY'ODON, Pal. de Beauv.—A genus of Funariaceæ (Acrocarpous Mosses). The only species, A. (*Bryum*) *dealbatum*, is rare in Britain.

Bibl. Müller, *Syn. Musc.* i. p. 127; Wilson, *Bryol. Brit.* p. 267.

AMBLY'OPHIS, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. Unattached; a single (red) eyespeck; a simple flagelliform filament, no tail. One species.

A. viridis (Pl. 23. fig. 55). Green; length 1-210 to 1-240''.

The anterior end of the body is colourless, and cleft so as to represent a two-lipped mouth. Near the middle of the body is a kind of nucleus.

Dujardin regards this animal as a *Euglena.*

Bibl. Ehr. *Infus.* p. 103; Duj. *Infus.* p. 636.

AMBLYSTEGIUM, Br. and Sch. — A genus of Mosses included under Hypnum by Müller and Wilson.

AMIBA, Duj. See Amœba.

AMMONIA, hydrochlorate or muriate of.—This salt crystallizes in cubes, octahedra, and trapezohedra. When crystallized rapidly it forms curious feathery aggregations (Pl. 7. fig. 9). The crystals do not polarize light.

AMMONIA, oxalate of.—This salt is readily prepared by neutralizing a solution of oxalic acid with ammonia or its carbonate, and evaporating.

It crystallizes in long slender needles, belonging to the right rhombic prismatic system. When mounted in Canada balsam, these form a very beautiful object for the polariscope (Pl. 31. fig. 7).

AMMONIA, oxalurate of; formerly known as the lithoxanthate of ammonia.

This salt may be prepared by mixing 1 part of uric acid with 32 parts of water, and heating the mixture in a porcelain capsule until it acquires a boiling temperature. Strong nitric acid, previously diluted with 2 parts of water, is next added in small quantities at a time, until nearly the whole of the uric acid is dissolved. The liquid is then boiled, filtered, mixed with excess of solution of ammonia, and concentrated by evaporation. As it cools, the salt is deposited in needles or warty groups of crystals. These are freed from the mother-liquor by pressure between blotting-paper, dissolved in warm water, and a little solution of ammonia added. On evaporation the pure salt separates.

The oxalurate of ammonia forms one of the most beautiful and interesting substances that can be examined by the polarizing microscope. When a small quantity of its aqueous solution is slowly evaporated on a slide, some of it usually crystallizes in circular crystalloid disks or very flat spheres, consisting of minute needles radiating from a centre and in an intimate state of mechanical adhesion; sometimes the extremities of the needles are seen projecting beyond the circumference of the disks. The latter appear colourless or yellowish by reflected light; pale or dark brown, or even black by transmitted light, according to their size and thickness. When immersed in Canada balsam, they become transparent, often nothing more being distinguishable than radiating lines, indicating the needles of which they are composed. But if examined by polarized light and with the analyzer, when these are so arranged that the plane of polarization of the analyzer is at right angles to that of the polarizer (the field being black), the disks present the appearance of beautiful little stars, sometimes almost white, at others splendidly coloured, each being also traversed by a black rectangular cross (Pl. 31. fig. 11).

On rotating the slide, no change is produced. But on rotating the analyzer or polarizer 90°, the arms of the cross appear to rotate, which, as there are no fixed points visible in the disks, gives rise to the appearance of the disks themselves rotating. When the analyzer has been rotated a quarter of a revolution, the former position of the

black cross is occupied by a white one, and the colours of the intermediate parts become complementary to (forming white light with) those which they at first possessed, these appearances being alternately reproduced at each quarter revolution.

If a plate of selenite is placed beneath the slide, the beauty of the objects is much augmented (Pl. 31. fig. 12). On some parts of the slide dendritic aggregations of the needles are seen (Pl. 31. fig. 11*a*).

Sometimes the colours are disposed in concentric rings; when these are well defined, a concentric arrangement of the groups of needles is distinguishable on examining the disks by common light.

A simple experiment will show the origin of the cross and the colours. If eight crystals of any doubly refracting salt be arranged upon a slide in the directions of equidistant radii of a circle, they may be regarded as forming two crosses, alternating in position. If the slide be placed under the microscope, with the plane of polarization of the polarizer and analyzer at right angles, and the crystals be simultaneously rotated and kept in the same relative position, a point will be reached at which each alternate crystal will become black, the intermediate ones appearing coloured; and on continuing the rotation, the crystals which were at first black will appear coloured, those which were coloured appearing black.

The blackness of the crystals arises from the plane of primitive polarization of the light transmitted by the polarizer being parallel with the optic or neutral axis of the crystals, consequently there is no double refraction and no interference to produce colour; whilst in the coloured crystals, the optic axis of which does not coincide with the plane of polarization, double refraction and interference ensue, by which the colours are produced. The tint of colour varies according to the thickness of the disks.

See Circular crystals and Polarization.

AMMONIA, purpurate of, or Murexide.—Is an artificial product of the decomposition of uric acid. It may be prepared by dissolving uric acid in dilute nitric acid, as directed under Ammonia, Oxalurate of. The solution is evaporated until it acquires a tile-red colour; then cooled to exactly 158° Fahr., and dilute solution of ammonia added to it, until it is neutralized. Half its bulk of water is then added, and the mixture deposits the salt in crystals as it cools.

The crystals form short, flattened, four-sided prisms (Pl. 7. fig. 10); they are ruby-red by transmitted light, and the two broad surfaces are emerald-green by reflected light. They are also analytic.

Bibl. See Chemistry.

AMMONIA, urate of. See Urates.

AMMONIO-CHLORIDE of Platinum. See Platinum.

AMŒBA, Ehr.—A genus of Rhizopoda, of the order Lobosa, and family Amœbæa.

Char. The same as that of the family; but the pseudopodia of one kind only.

These curious organisms constitute the simplest forms of animal beings; for they consist of a single kind of matter, a simple mass of sarcode. When first placed upon a slide, they represent minute rounded semi-transparent masses; but soon one or more rounded or pointed lobes, or transparent expansions, are seen to shoot out from the margin. These move almost imperceptibly along the slide, and, becoming fixed to it, slowly draw the mass towards the fixed point. They are usually found to contain within them Infusoria, Diatomaceæ, Desmidiaceæ or other minute Algæ serving as food; these bodies being involved in the same manner as occurs in the case of Actinophrys, a temporary digestive cavity being thus formed. Sometimes also vacuoles are seen within them, containing simply the surrounding liquid; these contract occasionally and disappear.

Ehrenberg admits four species; to these Dujardin has added ten, and others have since been added; but the characters cannot be depended upon.

They are found in almost all infusions which have not become putrid; also in the slimy *débris* covering bodies immersed in fresh or salt water.

Their size varies from 1-70 to 1-2800″.

Amœba diffluens (aquatic) is represented in the expanded state by Pl. 23. fig. 9*a*; and when contracted, by fig. 9*b*.

In some species a nucleus and a contractile vesicle have been described. *Amœba villosa* (Wallich) has one part of the body covered with short processes or villi.

Amœba-like movements of the sarcode or protoplasm are often perceptible in isolated normal and pathological structures—as in the white blood-globules, the liver-cells, the corpuscles of dropsical liquids, the embryonal cells of ova, &c.; also in various vege-

table cells, the root-cells of *Chara, Volvox,* the spores of Algæ, the Myxogastres, &c. It has been supposed that in this way species of *Amœba* may be produced.

An *Amœba* with a large cilium and a villous tail has been described by Carter; and a free swimming *Amœba* with a cilium by Tatem.

BIBL. Ehr. *Infus.* 126; Dujardin, *Inf.* 231; Auerbach, Siebold and Kölliker's *Zeitsch.* vii. 365; Schultze, *Polythal.*; Carter, *Ann. Nat. Hist.* 1856 and 1864; Wallich, *ibid.* 1863, p. 198; Bronn, *Amorphozoa,* 1859; Perty, *Z. Kenntn.* p. 188; Tatem, *Month. Mic. Journ.* i. p. 352.

AMŒBÆA, Ehr.—A family of Rhizopoda, of the order Lobosa.

Char. Animals shell-less, composed of a glutinous substance, without integument or internal structure, constantly changing form by the protrusion or retraction of parts of the body, whence result variable expansions; movement slow.

They are propagated by spontaneous fission. When cut or torn, each segment contracts upon itself and forms a new being. Granular spermatozoa formed from the nucleus, and ova formed from the sarcode, have been observed by Carter in *Amœba.*

Gen.: *Amœba.* Pseudopodia of one kind.

Podostoma. Pseudopodia of two kinds,—one large and for locomotion, the other in the form of a proboscis, and serving for nutrition.

Petalopus. Pseudopodia cylindrical, expanding at the ends into thin plates.

AMPELOMYCES, Ces. See OIDIUM.

AMPHIBLESTRA, Presl.—A genus of Adianteæ (Polypodioid Ferns). Exotic.

AMPHICAMPA, Ehr.—A doubtful genus of Fossil Diatomaceæ.

1. *A. Eruca* (Pl. 43. fig. 11).

2. *A. mirabilis* (Pl. 43. fig. 12).

Fossil at Tisar, Mexico.

BIBL. Ehrenberg, *Ber. d. Berl. Akad.* 1855, 86; and *Mikrogeologie.*

AMPHIDISCUS, Ehr.—A supposed genus of fossil Infusoria, consisting of bacillar spicules of sponges with discoidal ends (Pl. 37. fig. 19 *d*).

AMPHIDIUM, Nees.—A genus of Mosses, included under ZYGODON.

AMPHILEPTUS.—A genus of Infusoria, of the family Colpodea (Ehr.).

Eye-spot wanting; no tongue-like process; proboscis and tail present.

The so-called proboscis resembles in appearance a neck. The mouth is situated beneath the junction of the proboscis and the body.

Dujardin gives the following characters, placing the genus among his Paramecina. Body elongated, fusiform or lanceolate, narrowed at each end, or at least at the anterior extremity, and furnished with an oblique lateral mouth.

These animals are usually found in clear marsh water, and in streams, between aquatic plants. They are all furnished with cilia but one; in some these are arranged in longitudinal rows. Species:—

1. *Amphileptus anser,* E. (*Dileptus anser,* D.). Colourless; length 1-120″. Proboscis obtuse, as long as the body.

2. *A. margaritifer,* E. and D. Colourless; 1-72″. Proboscis acute, as long as the body.

3. *A. moniliger,* E. and D. Colourless; proboscis short; nucleus moniliform; 1-72 to 1-96″.

4. *A. viridis,* E. and D. Green; 1-120 to 1-46″.

5. *A. fasciola,* E. and D. Colourless; linear-lanceolate; 1-720 to 1-144″ (Pl. 23. f. 10 *a*, from above; *b*, side view).

6. *A. meleagris* (*Loxophyllum meleagris,* D.). Colourless; 1-72″ (Pl. 24. f. 42 *a*; *b*, anterior portion in side view).

7. *A. longicollis,* E. Colourless; rounded behind, tapering in front; 1-120 to 1-96″.

8. *A. papillosus,* E. Yellowish-brown; body covered with papillæ; 1-600 to 1-430″.

9. *A. vorax,* D. (*Trachelius vorax,* E.). Colourless.

10. *A. ovum,* D. (*Trachelius ovum,* E.). Colourless.

Claparède and Lachmann describe other species.

See TRACHELINA.

BIBL. Ehr. *Infusionsth.* p. 354; Dujardin, *Infus.* p. 483; Claparède and Lachmann, *Infus.* p. 349.

AMPHIMONAS.—A genus of Infusoria, of the family Monadina (Duj.).

Found in kept saline solutions and marsh water. Species:—

1. *A. dispar.* Colourless; length 1-3860 to 1-2700″ (Pl. 23. fig. 11).

2. *A. caudata* (*Bodo saltans*?, Ehr.). Colourless; 1-2180 to 1-1270″.

3. *A. brachiata.* Colourless.

BIBL. Dujardin, *Infus.* p. 292.

AMPHIMOR'PHINA, Neugeboren.—One of the accepted genera of the Nodosarine Foraminifera, in which the older portion

has grown on the Frondicularian plan, and the younger chambers are Nodosarian or Dentaline. Tertiary, Germany.

Bibl. *Verhand. Siebenbürg.*, 1850.

AMPHIPENTAS, Ehr.—A doubtful genus of fossil Diatomaceæ (Cohort Anguliferæ).

Char. Unattached; frustules solitary, bivalve, and pentagonal.

1. *A. Pentacrinus*; diam. 1-240″; Greek marl.

2. *A. alternans* (Pl. 19. fig. 11); Cuba.

Bibl. Ehrenb. *Ber. d. Berl. Ak.* 1840 and 1843, *Abhl.* 1841; Kützing, *Bacill.* p. 136.

AMPHIPLEURA, Kütz.—A genus of Diatomaceæ (Cohort Amphipleureæ).

Char. Frustules free, straight or slightly sigmoid; valves lanceolate or linear-lanceolate, with a median longitudinal line.

Ehrenberg regards the lines as corresponding to ridges. We have only had an opportunity of examining the frustules of one species, *A. pellucida* (Pl. 12. fig. 7 *a*, side view of frustule; *b*, of valve). In this, the frustules are very much flattened, so that the front view can only be seen as they are rolling over. The valves are furnished with a median line, which is thickened and expanded longitudinally at each end. There is no median nodule.

The valves appear to resemble those of *Nitzschia* in their inequality; but they are compressed in the opposite direction to those of that genus, and thus the median lines of both valves are visible at once. That the lines seen upon the frustules are the same as the median lines of the separated valves, is evident from their exhibiting the terminal expansions. This view is confirmed by the sides of the frustules being half as broad again as the separate valves. British species:—

1. *A. pellucida.* Aquatic, valves linear-lanceolate; length 1-225″. The valves are furnished with longitudinal and transverse striæ, of extreme delicacy, requiring the very best object-glasses of the largest aperture, and the most oblique light to render them visible. Sollitt estimates them at 125 to 130 in 1-1000″. These valves form the most difficult test-objects at present known for angular aperture and obliquity of light; but those of some species of other genera are probably much more difficult.

2. *A. rigida*, K. (*sigmoidea*, Sm.). Marine; valves narrowly linear-lanceolate, slightly sigmoid; length 1-150″ (Pl. 12. fig. 7 *c*, side view).

3. *A. Danica*, K. Valves lanceolate, truncate; length 1-400″; coast of Denmark.

4. *A. inflexa.* Marine; linear, lunate, slightly attenuate at ends, obtuse; length 1-330″.

Bibl. Kützing, *Bacillar.* p. 103; *Spec. Alg.* p. 88; Smith, *Brit. Diat.* i. p. 45; Rabenhorst, *Flor. Alg.* i. p. 143.

AMPHIPRORA, Ehr.—A genus of Diatomaceæ (Cohort Naviculeæ).

Char. Frustules free, solitary, constricted in the middle; valves convex, having a median keel, with a nodule at each end, and either a nodule or stauros in the middle.

Marine, or inhabitants of brackish water. The frustules are sometimes much twisted, occasionally resembling a violin in form, from one half of the frustule being in a longitudinal plane almost at right angles to that of the other. The surface of the valves is more or less distinctly marked with transverse striæ, which under high powers and proper manipulation are resolvable into dots or minute depressions, arranged as in Pl. 11. fig. 8. See Diatomaceæ. 13 British species:—

1. *A. alata*, E. Common (Pl. 12. fig. 8. *a*, side view; *b*, front view). Fr. twisted; fr. view linear, ends rounded; valves narrowly elliptical.

2. *A. constricta*, E. Fr. straight, narrow; valves with a transverse line, ends acute.

Bibl. Ehr. *Abh. Berl. Akad.* 1841, p. 333; Kützing, *Bacill.* p. 107; *Spec. Alg.* p. 93; Smith, *Brit. Diat.* i. p. 43, ii. p. 92; Greville, *Mic. Trans.* 1863, pp. 13, 20; 1865, p. 105; *Ann. Nat. Hist.* 1865, xvi. p. 5; Rabenhorst, *Flora Alg.* i. p. 253; Gregory, *Diat. of Clyde*, p. 33; Grun, *Verh. Wien*, 1860, p. 569; Donkin, *Qu. Mic. Journ.* 1861, p. 14.

AMPHISO'RUS.—The compound or aged individuals of *Orbitolites orbiculus*, having chambers on both faces of the disk, are grouped by Ehrenberg under this genus of his *Bryozoa polysomatia.*

Bibl. Ehrenberg, *Abhand. Berl. Akad.* 1838; Carpenter's *Intr. Foram.* p. 105.

AMPHISTE'GINA, D'Orb.—One of the high-class genera of *Foraminifera perforata*, of the Nummuline family. It differs from *Nummulina* mainly in not being symmetrical, one face being more conical than the other. On the flatter face the alar flaps of the chambers are as in *Nummulina*; but on the other they are packed in around the umbo among the chambers, to which they are attached by very narrow necks. The aperture also lies somewhat on this side of the median plane. Living abundantly in some

parts of the tropical seas; and found fossil in some Tertiary strata younger than those rich in Nummulites. Recent, South Seas; fossil, Middle Tertiary, Australia, Europe.

Amphistegina Haueri (Pl. 47. fig. 28).

BIBL. D'Orbigny, *For. Foss. Vien.*; Carpenter, *Introd. Foram.* p. 241.

AMPHIS'TOMA (*Holostomum, Diplodiscus*).—A genus of Entozoa of the family Trematoda.

Char. Body soft, oval, cylindrical or conical; intestine 2-branched; two pores, one anterior, the other posterior, forming a large sucker.

Rudolphi enumerates 21 species, of which 3 are doubtful. They are most common in birds, but sometimes occur in mammalia, reptiles, and fishes; generally inhabiting the alimentary canal; length from 1-10 to 4-5 of an inch.

BIBL. Dujardin, *Helminthes*, p. 327; Diesing, *Syst. Helm.*

AMPHITET'RAS, Ehr.—A genus of Diatomaceæ (Cohort Anguliferæ).

Char. Side view of the frustules rectangular, the angles sometimes produced; valves covered with depressions, which are readily seen under a low power.

This genus approaches *Isthmia* and *Biddulphia*, from which it differs in its rectangular and not compressed figure.

1. *A. antediluviana* (Pl. 12. fig. 9); *a*, frustules united; *b*, side view; *c*, front view; *d*, perspective view. Lateral surfaces of the frustules with concentric radiating depressions, their sides concave. British; marine.

2. *A. adriatica*. Depressions concentric and radiating; angles of the frustules obtuse; lateral surfaces of frustules with straight sides; Adriatic sea.

3. *A. parallela*. Depressions parallel; in Greek marl.

10 other species.

BIBL. Kützing, *Bacill.* p. 135; *Spec. Alg.* p. 133; Ehrenberg, *Abh. d. Berl. Akad.* 1839, pp. 122, 142; Greville, *Mic. Trans.* 1865, p. 105, 1866, p. 9; Rabenhorst, *Flor. Alg.* p. 318.

AM'PHORA, Ehr.—A genus of Diatomaceæ (Cohort Naviculeæ).

Char. Frustules solitary, free or adherent; valves with a nodule or a stauros at the middle of the margin on the inner side.

The nodules exist on the flat side of the frustules; the frustules are plano-convex; Pl. 12. fig. 10 *a* represents a transverse section; the side view of the frustules can only be seen when these are made to roll over by sliding the glass cover upon the slide with the mounted needle. (INTRODUCTION, p. xxiii.)

The valves are furnished with transverse striæ, resolvable into dots, but in some species these are excessively minute.

The species are both marine and aquatic.

1. *A. ovalis*, K. Aquatic; frustules turgid, oval, ends rounded or truncate; length 1-400″; common. (Pl. 12. fig. 10, front view; 10 *a* represents a transverse section.)

2. *A. minutissima*, S. Aquatic, adherent to other Diatomaceæ; valves with a stauros; length 1-1200″.

3. *A. costata*, S. Marine; ends beaked; valves longitudinally ribbed; length 1-500″.

4. *A. membranacea*, S. (Pl. 12. fig. 11); brackish water.

Rabenhorst describes 54 European and 22 other species.

BIBL. Kütz. *Bacill.* p. 107; *Spec. Alg.* p. 93; Smith, *Brit. Diat.* i. p. 19; Rabenhorst, *Flor. Alg.* p. 86.

AMYLIDE CELL, of Kützing. See PRIMORDIAL UTRICLE.

AM'YLOID.—This name was given by Schleiden and Vögel to a peculiar modification of vegetable substance met with in the thickening layers of the cell-walls, in the cotyledons of certain Leguminosæ, viz. *Schotia speciosa*, *S. latifolia*, *Hymenæa Courbaril*, *Mucuna urens*, *M. gigantea*, and the tamarind (*Tamarindus indica*); also of the common white Haricot bean. When in a dry condition, it is of a soft horny consistence; when wetted, it softens, becomes gelatinous and transparent; it is soluble in boiling water, strong acids, and in solution of potash, but not in alcohol or ether. It is coloured blue by iodine, like starch, the compound being soluble in water with change to a yellow colour. The 'amorphous starch,' described by Schleiden, in the seeds of *Cardamomum minus*, in the rhizomes of *Carex arenaria* and Sarsaparilla, seems scarcely distinct from amyloid; it forms a thick viscous layer lining the cells. Amyloid forms a transitional substance between starch and bassorin and cellulose, and probably presents modifications approaching more nearly to one or other of them in different plants.

When cellulose is treated with a mixture of 4 parts of sulphuric acid and 1 of water, it swells into a clear jelly, which is at first stiff, but gradually acquires liquidity; alcohol or water throws down from it white flakes of amyloid, which are coloured blue

like starch by iodine. It differs, however, from starch in the circumstance that the iodine can be washed out of it, and the blue colour made to disappear by the action of water, which is not the case with starch. See CELLULOSE and STARCH.

AMYLUM. See STARCH.

ANABAINA, Bory. See TRICHORMUS.

ANACALYPTA, Röhl.—A genus of Mosses, made a section of POTTIA by Müller.

BIBL. Müller, *Synops. Muscor.* i. p. 547; Wilson, *Bryol. Brit.* p. 97.

ANACH'ARIS, Rich.—A genus of Hydrocharidaceæ (aquatic Monocotyledonous Plants). *A. Alsinastrum*, Bab., which is apparently identical with *Udora canadensis*, a North American plant, has become widely diffused in Britain during the last few years in ponds and streams. It is of great interest to microscopic observers, on account of the facility with which the ROTATION of the cell-contents may be observed in its living tissues. It is commonly cultivated in jars of water for this purpose.

BIBL. Wenham, *Quarterly Journ. Mic. Science*, iii. p. 277.

ANACYS'TIS, Kütz.—An obscure genus of Palmellaceous Algæ.

Char. Fronds gelatinous, rounded, simple; coloured cells minute, crowded, green.

3 species; found on other algæ in pools, *A. Grevillei* (*Palmella Grev.*), on dead stalks of asparagus.

BIBL. Kütz. *Tab. Phycol.* i. pl. 9. figs. 2–4; *Sp. Alg.* p. 209; Berkeley, *Gleanings &c.*; Hassall, *Brit. Alg.* (*Coccochloris*).

ANALYTIC CRYSTALS.—This term was proposed by Fox Talbot, in 1837, to designate those crystals which possess the power of analyzing polarized light, like the tourmaline. The substances in which this property is best exhibited are the nitrate of potash, the sulphate of chrome and potash dissolved in tartaric acid by heat, boracic acid, the oxalate of chromium and potash, allantoin, hippuric acid, urea, oxalate of urea, uric acid, &c. They must be immersed in Canada balsam. The crystalline compound of disulphate of quinine with iodine is inferior to none in this power. The phenomena scarcely need description, since analytic crystals merely play the part of a thick plate of tourmaline, or a Nicol's prism: *i. e.* if polarized light be transmitted through them (a polarizer alone being used), in one position they suffer it to pass freely, while if they are rotated 90° they arrest or absorb it entirely, or to a greater or less extent; and if a plate of selenite, or other depolarizer, be placed beneath the slide upon which the crystals are situated (without the analyzer), the lateral surfaces are seen to be coloured, the complementary tints appearing at each quarter rotation.

Of course these crystals will act equally as polarizers and analyzers. Fox Talbot gives the following explanation of the cause of the phenomena in the crystals which he examined. When a beam of polarized light is transmitted very obliquely through a small prism of nitre, its outline generally exhibits two colours instead of one; for while the edge of the prism, which is on that side from whence the ray of light comes, is, for instance, red, the opposite edge will appear green. On reversing the polarization of the light, these colours are exchanged. This observation shows why the phenomenon only occurs in crystals possessing strong double refraction, like nitre, in which the refractive indices of the two rays are materially different. When a ray of common light is incident upon such a crystal, and therefore is divided into two rays oppositely polarized, both rays are transmitted through the central parts of the crystal, which are bounded by parallel planes, or by planes approaching to parallelism. But when the bounding planes of the crystal are much inclined to each other, and therefore refract the light in the manner of a prism, the refractive indices of the rays may differ so much, that while one passes freely through such a prism, the other cannot pass at all, but suffers total internal reflection, and is thereby dispersed; just as if the prism had a larger reflecting angle with respect to that ray than to the other. Therefore if two oppositely polarized rays are presented to such a crystal as in our experiment, one will be transmitted and the other not. That this is the true explanation appears from this, that when the oblique planes are well-formed and clearly defined by the microscope, the colour also is accurately limited by the same boundary; so that while this part analyzes the tints of a plate of sulphate of lime, the rest of the crystal is inactive.

That internal reflection and dispersion, however, are not the cause of the separation of the coloured rays, is shown by the fact that those lateral surfaces of crystals which, when viewed through the microscope (with the polarizer and plate of selenite alone), appear of a certain colour, say green, exhibit the complementary tint, red, when viewed with the naked eye from the side of the stage; hence the two coloured rays are separated merely by refraction.

The margins of cavities containing air and air-bubbles, which sometimes exist in the crystals, exhibit the colours in the same manner and from the same cause as the lateral oblique surfaces of the crystals.

Nothing can surpass the curious and beautiful appearance presented by analytic crystals, the delicacy and brilliant transparency of their coloured margins giving them the aspect of figures drawn with coloured ink.

Pl. 7. fig. 11 *a, b*, represent two crystals of nitre, viewed with the polarizer but neither the analyzer nor the plate of selenite; fig. 12, *a, b*, represent two crystals as seen when the polarizer and plate of selenite are used, exhibiting the complementary colours; fig. 12 *c* represents an air-bubble enclosed in the crystal. See DICHROISM and POLARIZATION.

BIBL. Brewster, *Phil. Trans.* 1835; Fox Talbot, *ibid.* 1837.

ANAULUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, compressed, subquadrate, not furnished with either tubular processes, nodules or apertures, but having lateral constrictions.

In the latter character it resembles *Biddulphia.*

Kützing admits one species:—

A. scalaris, Ehr. (Pl. 43. fig. 7). Valves turgid in the young state, very broad and flat when mature; having 4, 6, 8, or 14 lateral constrictions, which give the front view a ladder-like appearance; marine; diameter 1-470 to 1-175″. Antarctic Ocean.

A. indicus, Ehr.= *Terpsinoe indica*, Kütz.

BIBL. Ehrenberg, *Bericht. d. Berl. Akad.* 1844, p. 197; 1845, p. 361; Kützing, *Spec. Alg.* pp. 119, 120.

ANCHORELLA, Cuvier.—A genus of Crustacea, of the order Siphonostoma.

Char. Body short, produced in front into a kind of neck, which is transversely rugose; arms two, furnished with a sucker or adhesive disk at the end, and confluent throughout their length.

Two British species:—

1. *A. uncinata* (Pl. 14. fig. 7), milk-white; found on the gills and gill-covers of the cod, haddock, and whiting; length about 1-2″.

2. *A. rugosa*, found on a species of cod; length about 1-3″.

The above characters refer to the female.

BIBL. Baird, *Brit. Entomostraca*, p. 336.

ANCYRIUM, Werneck.—An obscure genus of Infusoria.

Char. That of an Enterodelous *Bodo*, with a moveable setaceous foot.

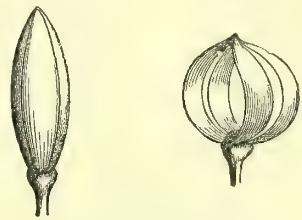
6 (?) species.

BIBL. Werneck, *Ber. d. Berlin. Akad.* 1841, p. 377.

ANDRÆ'A, Ehrh.—A genus of Mosses. See ANDRÆACEÆ.

ANDRÆACEÆ.—A family of Schistocarpous Mosses, characterized especially by

Fig. 10. Fig. 11.



Andræa rupestris.

Fig. 10. A sporange not yet open.
Fig. 11. A sporange burst into four valves, united at their points. Magnified 20 diameters.

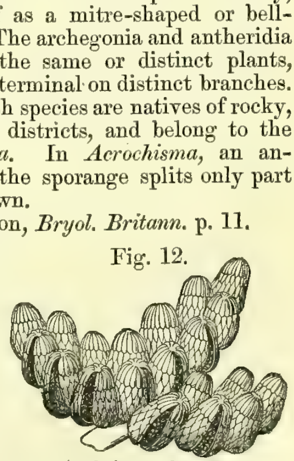
the peculiar mode of splitting of the fruit, somewhat analogous to that which is found in *Jungermannia*, the urn-shaped capsule dividing perpendicularly when ripe into four or eight valves, which usually remain attached together at their points (figs. 10 and 11). But the capsules always differ from those of *Jungermannia* in the presence of a columella. The cells of the leaves are parenchymatous, with their walls thickened, and somewhat papillose on the surface. The calyptra at first covers the capsule entirely, then splits off as a mitre-shaped or bell-shaped cup. The archegonia and antheridia are either on the same or distinct plants, and the latter terminal on distinct branches. The few British species are natives of rocky, usually alpine districts, and belong to the genus *Andræa.* In *Acrochisma*, an antarctic genus, the sporange splits only part of the way down.

BIBL. Wilson, *Bryol. Britann.* p. 11.

ANEI'MIA, Swartz. — A genus of Schizæous Ferns. Exotic (fig. 12).

The fertile fronds, bearing the sporangia, are reduced to mere ribs.

Fig. 12.



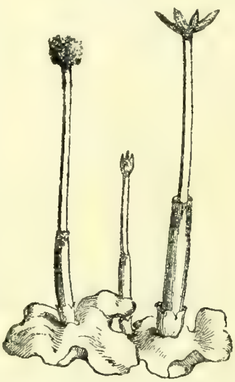
Aneimia mandioccana.
Group of sporanges bursting to discharge the spores. Magnified.

ANEL'LIDA. See ANNULATA.

ANEURA, Dumortier. — A genus of Pellieæ (Hepaticæ), growing in wet places, containing 3 British species:

1. *A. pinguis*, L. Frond irregularly branched, margins sinuate, calyptra smooth, whole plant brownish-green. = *J. pinguis*, Hooker, Br. Jungerm. t. 46 (fig. 13).

Fig. 13.

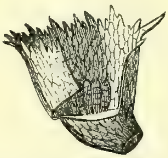


Aneura pinguis.
Bursting sporanges. Magnified 2 diameters.

2. *A. multifida*, L. Frond bipinnately divided, calyptra tuberculate. = *J. multifida*, Hooker, Br. Jungerm. t. 45 (figs. 14 and 15).

Fig. 14.

Fig. 15.



Aneura multifida.

Fig. 14. Portion of a frond with young perichætes, magnified 20 diameters.
Fig. 15. A perichæte, more magnified, cut open to show the archegonia.

3. *A. palmata*, Nees.—Frond palmate, calyptra tuberculate. = *J. multifida*, var. *palmata*, Hooker.

Bibl. Hooker, *Brit. Jungermanniæ.*

ANGIOPTERIS, Hoffmann.—A genus of Marattiaceous Ferns. Exotic.

ANGUIL'LULA, Müller (*Rhabditis*, Duj.).—A genus of animals, formerly placed among the Infusoria, but arranged in the order Nematoidea of the class Entozoa by modern zoologists. The popularly known "eels" in vinegar and paste, belong to this genus.

Char. Body filiform, narrowed at the ends; mouth terminal, round, naked; anus subterminal; tail of male either naked or furnished with a membrane (winged); a double spiculum; tail of female conical, acute. Mouth succeeded by an oblong cavity (pharynx); stomach top-shaped or spherical, furnished with a kind of dental armature. Tail of the female frequently prolonged into a fine point. Uterus bifid; vulva situated near the posterior third of the body. Oviparous or viviparous.

These animals are especially remarkable and interesting on account of their great tenacity of life; resembling in this respect the Tardigrada and Rotatoria. Thus *Ang. fluviatilis*, when existing in places exposed to the heat of the sun, will dry up and become hard and brittle. But as soon as remoistened by rain, it revives, swells up, becomes soft, takes food and exercises its reproductive functions as before. The same faculty is possessed to an extraordinary degree by *Ang. tritici*, which will revive after having been kept in a dry state for more than five years. Nor are they destroyed by being frozen.

1. *Ang. fluviatilis* (?) (*Ang. terrestris*, Duj.) (Pl. 16. fig. 4). White, about fifteen times as long as broad; œsophagus fusiform, expanded posteriorly so as to become continuous with the much larger stomach; length of male 1-50 to 1-12″.

Found in wet moss and moist earth, whence it gets washed into rivers and ditches; sometimes also in the intestinal canal of snails, frogs, fishes, worms, and insects.

2. *Ang. aceti* (Pl. 16. fig. 5). From 30 to 45 times as long as broad, narrowed posteriorly and terminated by a drawn-out point; œsophagus cylindrical; tail conical, pointed; length 1-30 to 1-17″.

This species was formerly very common in vinegar, and the "eels in vinegar" were favourite popular microscopic objects. To the freedom of our vinegar from mucilage, and the addition of sulphuric acid allowed by law, must be attributed their comparative rarity in the present day. Still, if to cheap vinegar, in which a few may be perceived by a hand-lens, a little flour be added, they may be bred in swarms.

3. *Ang. tritici* (Pl. 16. fig. 6). 20 times as long as broad in the adult state; length 1-42 to 1-4″; pharynx with an exsertile spear, trilobed at the base.

Found in blighted wheat, and sometimes infesting the young plants, burrowing in the leaf-sheaths, where we have found them reproducing by ova, in great numbers.

4. *Ang. glutinis.* About 20 times as long as broad, terminating posteriorly in a fine elongated point; length 1-15″.

Found in sour paste.

Other so-called *Anguillulæ* are found in the same situations as *A. fluviatilis.* See Enoplidæ.

It is almost impossible to dissect these minute beings in the ordinary manner; the best method of proceeding is to wound the body, and gently press out the contents under water.

Bibl. Dugès, *Ann. d. Sc. Nat.* 1826, ix.; Bauer, *Phil. Trans.* 1823; Ehrenberg, *Symbol. Phys.*; Dujardin, *Helminthes*; Davaine, *Ann. N. H.* 1856, xviii. p. 268; *Sur l'Anguill. d. blé niellé*; Kühn, Sieb. & Kölliker's *Zeitsch.* 1857, p. 129; Bastian, *Linn. Trans.* 1865, xxv. 73; Cobbold, *Entozoa.*

ANGUILLU'LIDÆ.—A family of non-parasitic nematoid worms.

This family corresponds pretty nearly to the Enoplidæ of Dujardin. The genera have been revised by Bastian in an excellent monograph, in which several new genera and 100 new species are described and figured; to which we must refer those who are specially interested in this curious group.

Bibl. Bastian, *Trans. Linn. Soc.* xxv. 73, 1865.

ANGUINA'RIA, Lamk. (Ætea, Lamx.). —A genus of marine Polyzoa, of the suborder Cheilostomata, and family Eucratiadæ.

Char. Cells tubular, erect, scattered, rising from a creeping fistular fibre adnate to a foreign base; aperture terminal or subterminal. Two British species:—

1. *A. spatulata.* Cells spatulate at the end, curved, ringed.

2. *A. truncata.* Cells truncate at the end, surface punctate, not ringed.

Two foreign species: *A. dilatata, A. ligulata.*

Bibl. Johnston, *Brit. Zooph.* 292; Gosse, *Mar. Zool.* ii. 13; Busk, *Catalogue Mar. Polyz.* 31.

ANGUINEL'LA, V. Bened.—A genus of marine Polyzoa, of the suborder Ctenostomata, and family Vesiculariadæ.

One British species: *A. palmata,* palmately branched, largely composed of mud; tentacles 12; no gizzard.

Bibl. Gosse, *Mar. Zool.* ii. 22; Van Beneden, *Rech. sur les Bryozoaires, &c.*

ANGULAR APERTURE.—The angular aperture of an object-glass is the angle measured by the arc of a circle, the centre of which is formed by the focal point of the object-glass, the radii being formed by the most extreme lateral rays which the object-glass admits.

Thus let fig. 16 represent a perpendicular section of the lowest combination of an object-glass of small aperture: *a* is the

Fig. 16.

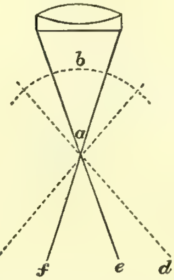
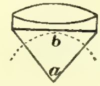


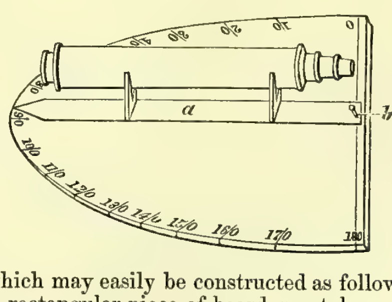
Fig. 17.



angle of aperture; and *f, e* are the most oblique rays which the object-glass will admit; the angle is measured by the dotted arc *b*. In the object-glass of larger aperture, fig. 17, the arc *b* which measures the angle is much larger, and the radii representing the extreme lateral rays are much more oblique. Hence it is evident that the object-glass of larger aperture admits all those rays admitted by that of less aperture and a certain number of other rays, these being more oblique.

Measurement of the angle of aperture.—It is of the utmost importance to know the angle of aperture of the object-glasses used in investigations; because the appearances presented by objects vary according to the magnitude of this angle, and this variation must always be taken into account in determining the structure of an object from its appearance. A particular piece of apparatus is requisite for this purpose (fig. 18),

Fig. 18.



which may easily be constructed as follows. A rectangular piece of board must be procured, the shortest sides of which are about 2 inches longer than the body of the micro-

scope, and the longer sides twice this length. A small hole must then be made opposite the middle of one of the long sides, at about half an inch from its margin, and from this, as a centre, a semicircle must be traced upon the board, and the semicircular line divided into 180°; the portions outside the semicircle being cut away. The wooden plate of this form is shown in perspective in the woodcut. A flat thin piece of wood (*a*) rather broader than the body of the microscope, a little longer than the radius of the semicircle and pointed at one end, is then placed upon the board in such manner that the pointed end corresponds with the graduated margin, whilst the other end is transfixed by a pin (*b*) which below is driven into the board. Thus we have a rotating arm or radius of the semicircle, which may be compared to the hand of a watch or clock, the pin forming the centre of rotation. To the upper surface of this arm are glued two thin pieces of wood, excavated in the middle, so as to form supports for the body of the microscope; the excavations should be triangular, the apex being directed downwards.

When used, the object-glass to be tested is screwed to the end of the body next the pin, and so adjusted that its focal point is as nearly as possible perpendicularly over the pin. A lamp is placed 2 or 3 yards from the board and upon exactly the same level as the axis of the body of the microscope, the straight side of the board being next the lamp; and when the arm has been so adjusted that the pointed end is opposite 90°, the lamp is so placed that the flame is seen through the body of the microscope. The eyepiece is next put into the other end. The arm supporting the body of the microscope is then moved on one side, the body looked through in the usual manner, until the field is seen to be divided into two parts, a dark and a luminous half; the degree which the pointed end of the arm coincides with is then noted, and the arm is moved in the other direction until the division of the field is again seen; the number of degrees included in the arc thus traversed, measures the angle of aperture.

It has been objected that this method does not afford an exact estimate of the angle of aperture. But it is sufficient for all practical purposes; for it is a fact that an object-glass which, according to the above method, is of larger aperture than another, will display markings which the one of less aperture will not.

As an object-glass of large aperture admits a greater number of oblique rays than one of less aperture, the central rays being in nowise interfered with, so the total number of rays admitted is greater, and objects will thereby be more brilliantly illuminated. This is one of the advantages gained by the use of an object-glass of large aperture; and the explanation applies especially to its use in the examination of opaque objects, in regard to which it can be readily understood that a greater number of the rays reflected from all parts of an object being admitted, will render it more luminous and distinct. In this case the same effect would be produced by condensing an additional amount of light upon the object.

But strictly speaking, large angular aperture in an object-glass used in the examination of opaque objects is disadvantageous; for although objects thus viewed appear very luminous, brilliant and beautiful, yet a number of the rays which cannot enter an object-glass of small aperture from their obliquity, and which thus map out as it were the form and structural appearances of the object, are admitted by an object-glass of large aperture, and thus the contrast by which the various parts are rendered visible will be destroyed. This applies especially to uncoloured objects; for those which are coloured are best seen under a glass of larger aperture, the difference between the tints of colour reflected being sufficient to render each part distinct.

There is, however, another far more important use of large angular aperture in an object-glass. It was first found by Goring that longitudinal and transverse lines upon the scales of Lepidopterous and other insects could be seen under certain object-glasses, but not under others; and that the power of displaying these, or the penetrating power of the object-glass, as it is called, depended upon the magnitude of the angular aperture. The same has since been found the case with the markings upon the valves of the Diatomaceæ.

1. If the prepared valve of a *Gyrosigma* be examined under an object-glass of 1-4 or 1-8 of an inch focus, and an angular aperture of 60° or 70°, as illuminated by the ordinary light of the mirror, nothing more is seen than the more or less coloured valve with a distinct outline, the central line and the nodules; and no change is produced in the appearances, however intensely the object may be illuminated. But

if an object-glass of larger angular aperture be used, a number of fine dark parallel lines are seen traversing the valve. Hence the object-glass of larger aperture possesses a particular power of rendering indications of structure evident, which is not possessed by the one of less aperture.

2. If, in the same experiment, the mirror be brought towards one side of the stage, and the light be then thrown upon the object, the lines will become more distinct if previously visible, and frequently visible when not so before.

3. Placing a stop in the condensing lenses of the achromatic condenser or object-glass will increase the distinctness with which the markings are seen, if already visible, and will frequently render them visible when not so before.

These experiments show, that using an object-glass of large aperture in the examination of an object, bringing the mirror to one side, and placing a central stop in the object-glass or the condenser, or in both, produce the same effect, viz. that of rendering the markings upon an object visible when not so previously, or of rendering them more distinct if previously visible. And it is evident that the alterations of the conditions under which the object is examined in the above experiments, involve simply the viewing of the object when illuminated entirely or more completely by oblique light. For an object-glass of large aperture admits more oblique rays than one of less aperture, the central rays being in no wise interfered with; inclining the mirror to one side, causes all the rays which are reflected from it to become oblique; and the use of central stops excludes all the central rays, so that only the oblique rays are admitted. Hence the visibility or greater distinctness of the markings upon an object depends upon its illumination by oblique light.

Experiment also shows that the degree of obliquity of the light requisite, varies with the delicacy or fineness of the markings, being greater as these are more delicate; so that the most delicate markings require the most oblique light which can possibly be obtained, to render them evident, and the angular aperture of the object-glass must necessarily be proportionately large, otherwise none of these oblique rays could enter it.

In attempting to explain these phenomena, we may take the opportunity of examining somewhat minutely the reason why objects become visible to us under various circumstances.

The ordinary cause of objects becoming visible to us under the microscope, is that a certain number of the rays of light transmitted through or incident upon them or their parts, either become absorbed, refracted or reflected. Hence the parts at which refraction or absorption occurs, may become either coloured or dark, whilst those which transmit or reflect the light, become luminous. We shall leave the cases of absorption and reflection out of the question at present, and consider only those of refraction.

If the parts which refract the light are large in proportion to the power of the object-glass, and of irregular form, they will refract a certain number of rays so that these cannot enter the object-glass, and they will hence become dark, and will map out, as it were, in the image formed of the object, the structural peculiarities of the object. But if the parts are minute, of a curved form and approximatively symmetrical, they will act upon the light transmitted through them in the manner of lenses, and their luminous or dark appearance will vary according to the relation of the foci of these to that of the object-glass. Thus, the parts of an object may appear dark and defined, from the refraction of the light from the field of the microscope; also, from the concentration or dispersion of portions of the light by these parts, all the rays being admitted by the object-glass, or entering the field. In speaking of the parts being small or large, it must be understood that the refractive powers of the objects are assumed to be the same; for if the object be large and the substance of which it is composed have a low refractive power, the same effect may be produced as if the object were small and of high refractive power, the form being also the same.

Another condition, rather physiological than optical, is concerned in the question of the distinctness with which an object is seen, nay, even of its absolute visibility. It consists in the relation which the luminousness or darkness of an object bears to that of the field or background upon which it is apparently situated; and all objects, even those seen with the naked eye, may be regarded as viewed upon a back-ground or field, comparably to an object viewed in the field of the microscope. The familiar instance of the visibility of the stars by day from the bottom of a coal-pit, whilst invi-

sible from the surface of the earth, may serve to illustrate this point. The same phenomenon is constantly met with in microscopic investigations; thus it is well known that parts of structure which are visible most clearly by the light of a lamp in a dark room, cannot be distinguished when the room is illuminated by ordinary daylight; and luminous objects are best seen on a black ground, and dark objects on a light ground.

The refraction of the light out of the field of the microscope or beyond the angle of aperture of the object-glass, is the ordinary cause of the outlines of objects becoming visible; and in these cases an increase of the angular aperture of the object-glass will impair their distinctness, because it will allow of the admission of those rays which would otherwise have been refracted from the field, and the margins will become more luminous and less contrasted with the luminous field. All that is required here is that the object-glass shall be achromatic, and that the marginal rays shall not be decomposed, so that any of the coloured rays should enter the field; in which case, the margins of the objects would appear coloured instead of black, and thus the contrast requisite for distinctness would be lost.

The cause of the distinctness of an object by refraction, all or nearly all the rays entering the field of the microscope, may be investigated in a drop of oil immersed in water, or in a drop of milk, as illuminated by light reflected from an ordinary mirror. The refractive power of the globules is so great and their form such, that each exerts the action of a minute spherical lens; and the parts within the margin will appear light or dark according to the relation of the focus of the little lens to that of the object-glass. Under an object-glass of small aperture and moderate power, the outline will always appear black, because the marginal rays do not enter the object-glass.

But in certain objects, the irregularities of structure are of such extreme minuteness, or the difference of the refractive power of the various portions of the structure is so slight, that the course of the rays is but little altered by passing through them; and under ordinary illumination, all the rays will enter the object-glass; neither are the rays accumulated into little cones or parcels of sufficient intensity to map out the little light or dark spots in the field of the microscope according to the relation of their lenticular foci to that of the object-glass.

Let us take the instance of an object with minute depressions on the surface, as the valve of a *Gyrosigma* (*Pleurosigma*). These are so minute, that when the light reflected from the ordinary mirror is used, the rays passing through the depressed and the undepressed portions are not sufficiently refracted to cause either set to be excluded from the object-glass, consequently both sets will enter it. This may be supposed to be represented in fig. 19, where the slightly oblique and converging rays passing through a portion of the valve become separated into two sets, one passing through the thinner depressed portions, the other through the thicker and undepressed portions; both sets enter the object glass.

Fig. 19.

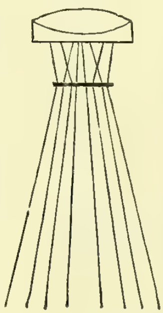
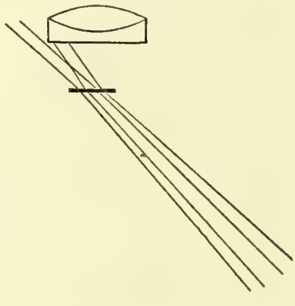


Fig. 20.



But on transmitting oblique light through the object, as represented in fig. 20, one set of the rays will be refracted so as not to enter the object-glass, whilst the other set will gain admission; thus the two parts, which have differently refracted the rays, will become distinct. If the markings were more delicate, or the difference between the refractive power of the two portions of the valve were less than that represented in fig. 20, both sets would enter the object-glass. But on rendering the light still more oblique, one set would be again excluded, from being refracted out of the field. Hence it is evident why the angular aperture of the object-glass must be larger, as the

markings are finer, or the difference between the refractive power of the two portions of tissue is less; because the obliquity of the light requisite to cause the exclusion of one set of the rays will be very great, and the other set will be too oblique to enter the object-glass, unless it be of correspondingly large aperture.

The most difficult point to explain, has been how it is that an object-glass of large angular aperture will render markings evident which were not visible under an object-glass of smaller aperture; because it would naturally be imagined that the larger aperture would admit both sets of rays (fig. 20), one of which was excluded by the object-glass of smaller aperture. The difficulty vanishes when it is recollected that the additional rays admitted by the object-glass of larger aperture are more oblique; hence one set of these rays will be refracted from the field of the microscope, whilst the other set will enter the object-glass, and will illuminate the more highly refractive parts of the object; thus the two kinds of differently refractive structure become distinctly separated, one appearing dark, the other luminous; and thus we illuminate one part of the object, whilst the illumination of the other is not increased. Or, to simplify this very important point, the object may be regarded as illuminated by two sets of rays, one corresponding to those admitted by the object-glass of small aperture, the other set corresponding to these plus those admitted by the excess of angular aperture of the second object-glass over the first; the first set of rays not being sufficiently oblique to allow of a portion of them being refracted beyond the angular aperture of the first object-glass, whilst the second set are so. Hence under the object-glass of larger aperture, the distinctness of the markings is impaired by the admission of the first set of rays. Now this always occurs when objects are examined under an object-glass of large aperture; although the more oblique rays render the markings visible, by their illuminating one part of the object and not the other, the less oblique rays render them indistinct by illuminating both parts, unless the central stop be used, which totally intercepts all but the very oblique rays, and allows the markings to be seen in perfection, as illuminated by the more oblique rays alone.

Refraction of the rays of light has alone been considered thus far; the action of oblique light and angular aperture in relation to colour and reflection has been neglected. The question of colour is easily answered. Neither oblique light nor large angular aperture possesses any power of rendering coloured transparent objects more distinct; and markings, when arising from the presence of pigment, are perfectly visible under an object-glass of small aperture, and the ordinary light of the mirror.

It has been assumed that the oblique light requisite for the display of the markings upon objects is separated into two sets of rays by refraction; but it might be questioned whether these are not separated by reflection. There can be no doubt that the latter is not generally the case: perhaps the most important reason which may be assigned for this is, the considerable comparative breadth of the luminous portions, of the valve of the *Gyrosigma* for instance. On transmitting unilateral light obliquely through the valve of an *Isthmia*, in which the depressions are very large, in such manner that part of it is reflected by portions of them, it is easily seen how small the amount of reflected light is; and this because the surface of the depressions is curved, and thus the portions inclined at the requisite angle for reflection are also very small. As the amount of light reflected is so small in this case, it would be inappreciable in that of the *Gyrosigma*, in which the depressions are so exceedingly minute. In fact, attention to this point affords a means of distinguishing whether an object is illuminated by reflection or refraction. When, however, the light is extremely oblique, the light parts of objects are mostly illuminated by reflection.

It has been shown, that the efficacy of large angular aperture depends upon the illumination of the objects by oblique light; and that the action of oblique light depends upon one set of rays being usually refracted from the field. Let us now attempt to trace the relation of the penetrating power of an object-glass to its defining power. It has been stated, that penetrating power depends upon angular aperture; and as angular aperture owes its efficacy to oblique light, the relation of oblique light to penetration is evident. Is there any essential difference between penetrating and defining power? This question will be best answered by experiment. If we take a fragment of the valve of an *Isthmia*, and examine it under a high power of small aperture, all the parts are very distinctly seen by the ordinary light

of the mirror; and the various depths of shadow of the different parts of the depressions and the undepressed portions render these also clearly distinguishable (Pl. 13. fig. 2 *c*); and when an object-glass of very large aperture is used, the distinctness is rather impaired than improved. But if we examine a fragment of the valve of a *Gyrosigma*, and this requires an object-glass of large aperture to render the markings visible, no distinction of the various parts of the depressions and the undepressed portions is visible; all we see is, that the depressions, as a whole, are dark, and the undepressed portions are luminous (Pl. 11. figs. 39, 40, 48). Hence the *Isthmia* requires defining power, whilst the *Gyrosigma* requires penetrating power and large angle of aperture, to exhibit the markings; yet the structures differ only in size. And there can be no doubt that if we could examine the valve of the *Gyrosigma* under a power as high relatively to the size of the depressions, as that under which we can examine the *Isthmia*, the same relations being preserved between the angle of aperture of the object-glass and the angular inclination of the refracted rays, the various parts of the depressions and the undepressed portions would be equally recognizable in both cases.

The same relation applies to fine lines scratched or etched upon glass. It was noticed by Goring, that although the lines on the scales of insects required an object-glass of comparatively large aperture to show them, yet those existing upon glass micrometers did not so. But this statement is only partially correct; for although the coarser lines upon micrometers are well seen under an object-glass of small aperture with good defining power and direct light, yet the finest lines upon Nobert's test-slide require penetrating power in the object-glass, and oblique light. Thus, R. Beck found that a $\frac{1}{8}$th-in. object-glass of 120° would show all the 20 sets of Nobert's lines; when cut down to 110°, it would not resolve the 20th band; at 100° the 17th was the limit; at 80° the 14th; and at 60° the 10th.

In conclusion, it may be noticed that these remarks have been principally confined to one class of objects requiring penetrating power, viz. the valves of the Diatomaceæ. This has been done because the scales of Insects, which may be regarded as forming the type of the other class, involve considerations of a mixed kind, which would have tended to confuse the subject. The longitudinal ridges upon the scales of Insects, in regard to their relation to penetration, may be viewed in the same light as the undepressed portions of the valves of the Diatomaceæ; and the same explanation will apply to the visibility of the one as to the other, under the various conditions.

The transverse lines seen upon the scales of insects are noticed under SCALES OF INSECTS. The structure of the valves of the DIATOMACEÆ is discussed under that head; see also INTRODUCTION, p. xxxiv, *l*.

We have thought it better to refer the angular apertures of the various object-glasses to the article TEST-OBJECTS.

BIBL. Lister, *Phil. Trans.* cxxi; Goring, *Micrographia*; Pritchard, *Microscopic Cabinet*; Gillett, *Proc. Roy. Soc.* vii. 16; Wenham, *Month. Micr. Journ.* iii. p. 300, iv. p. 124; Mayall, *Month. Micr. Journ.* i. p. 169, ii. p. 79; Brakey, *M. M. J.* iv. p. 237; Pigott, *M. M. J.* iii. p. 305, iv. p. 134; R. Beck, *Treatise &c.*, p. 19.

ANIMAL.—The definition of an animal in reference to the distinction from vegetables is discussed in the article VEGETABLES.

ANIMALCULE.—A little animal; a term usually applied to the Infusoria, Rotatoria, &c. It was formerly applied also to many of the lower Algæ. The Latin term *animalculum* (plural *animalcula*) is frequently met with.

ANIMAL KINGDOM.—In accordance with our plan, as laid down in the Preface, we give here a tabular view of the animal kingdom, so that the position of the various classes and orders alluded to in various parts of this work may be readily found. Those classes, orders, families and genera to which particular interest is attached in relation to structure or other qualities, which the microscope is required to investigate, are specially treated of under their respective heads.

Kingdom. ANIMA'LIA.

Subkingdom I. VERTEBRA'TA.

Class I. MAMMA'LIA.

Order 1. BI'MANA.
Homo, man.

Order 2. QUADRU'MANA.
Simia, ape; *Cercopithecus*, common monkey; *Semnopithecus*, Indian monkey.

Order 3. CHEIROP'TERA.
Vespertilio, bat.

Order 4. INSECTI'VORA.
Erinaceus, hedgehog; *Talpa*, mole.
Order 5. CARNI'VORA.
Canis, dog and wolf; *Ursus*, bear; *Felis*, lion; *Phoca*, seal; *Nasua*, coati-mondi.
Order 6. CETA'CEA.
Balæna, whale; *Phocæna*, porpoise; *Halicore*, dugong.
Order 7. PACHYDER'MATA.
Equus, horse; *Elephas*, elephant; *Sus*, hog; *Hippopotamus*; *Choiropotamus*.
Order 8. RUMINAN'TIA.
Bos, ox; *Camelus*, camel; *Cervus*, deer; *Capra*, goat; *Ovis*, sheep.
Order 9. EDENTA'TA.
Dasypus, armadillo; *Bradypus*, sloth.
Order 10. RODEN'TIA.
Cavia, guinea-pig; *Lepus*, hare; *Mus*, mouse and rat; *Sciurus*, squirrel; *Castor*, beaver and musk-quash; *Chinchilla*.
Order 11. MARSUPIA'LIA.
Macropus, kangaroo; *Didelphys*, opossum.
Order 12. MONOTREM'ATA.
Ornithorhynchus, duck-billed platypus.

Class II. AVES, birds.

Order 1. RAPTO'RES; birds of prey.
Aquila, eagle; *Strix*, owl.
Order 2. INSESSO'RES; perchers.
Fringilla, finch; *Hirundo*, swallow; *Turdus*, thrush, blackbird.
Order 3. SCANSO'RES; climbers.
Cuculus, cuckoo; *Psittacus*, parrot.
Order 4. GALLI'NA.
Gallus, fowl; *Columba*, pigeon.
Order 5. GRALLATO'RES.
Struthio, ostrich; *Grus*, crane.
Order 6. NATATO'RES.
Larus, gull; *Anas*, duck; *Anser*, goose.

Class III. REPTILIA, reptiles.

Order 1. CHELO'NIA.
Testudo, Tortoise.
Order 2. SAU'RIA.
Crocodilus, crocodile; *Lacerta*, lizard.
Order 3. OPHID'IA.
Boa; *Coluber*, snake.
Order 4. BATRA'CHIA.
Rana, frog; *Bufo*, toad; *Triton*, water-lizard; *Menopoma*.
Order 5. PERENNIBRANCHIA'TA.
Siren.

Class IV. PISCES, fishes.

Order 1. GANOI'DEA.
Lepidosteus, bony pike; *Sturio*, sturgeon.
Order 2. PLACOI'DEA.
Squalus, shark; *Raia*, ray.
Order 3. CTENOI'DEA.
Perca, perch.
Order 4. CYCLOI'DEA.
Salmo, salmon; *Clupea*, herring; *Cyprinus*, carp.

Subkingdom II. MOLLUSCA.

Class I. CEPHALOP'ODA.
Sepia, cuttle-fish.
Class II. GASTEROP'ODA.
Helix, snail; *Limax*, slug.
Class III. PTEROP'ODA.
Clio.
Class IV. CONCHIF'ERA, shell-fish.
Ostrea, oyster; *Mytilus*, mussel.
Class V. BRACHIOP'ODA.
Terebratula, lamp-shell.
Class VI. TUNICA'TA †.
Ascidia, *Salpa*, *Botryllus*.
Class VII. POLYZO'A (BRYOZOA) †, Sea-mats, &c.

†† These two classes form the Molluscoida of Milne-Edwards.

Subkingdom III. ARTICULATA (*Arthro-p'oda*).

Class I. CRUSTACEA, crabs, lobster, &c.

Order 1. DECAP'ODA.
Cancer, crab; *Astacus*, lobster and cray-fish.
Order 2. STOMAP'ODA.
Squilla.
Order 3. AMPHIP'ODA.
Gammarus, freshwater shrimp.
Order 4. ISOP'ODA.
Oniscus, wood-louse; *Asellus*, water wood-louse; *Limnoria*.
Order 5. PHYLLOP'ODA †.
Branchipus, *Artemia*.
Order 6. CLADOC'ERA †.
Daphnia, water-fleas.
Order 7. CIRRIPE'DIA (*Cirrhopoda*).
Balanus, acorn-shell; *Anatifa*.
Order 8. COPEP'ODA †.
Cyclops.
Order 9. OSTRACO'DA †.
Cypris.
Order 10. SIPHONOS'TOMA (*Ichthyo-phthira*); fish-lice.

Order 11. Pœcilop'oda.
Limulus, king-crab.

†††† These four orders form the Entomostraca (water-fleas) of some authors.

Class II. Arachni'da, spiders.
Order 1. Arane'ida.
Aranea, house-spider; *Epeira*, garden-spider.
Order 2. Pedipal'pi.
Scorpio, scorpion.
Order 3. Solif'uga.
Galeodes.
Order 4. Pseudoscorpio'nes.
Chelifer.
Order 5. Phalangi'ta.
Phalangium, harvest-spider.
Order 6. Acari'na.
Acarus, mites.
Order 7. Tardig'rada (*Colopoda*); water-bears.
Order 8. Pycnogon'ida (*Polygonopoda*).
Pycnogonum.

Class III. Insecta, insects.
Order 1. Coleop'tera.
Beetles.
Order 2. Orthop'tera.
Blatta, cockroach; *Acheta*, cricket.
Order 3. Hemip'tera.
Cimex, bug; *Aphis*; *Aphrophora*, cuckoo-spit.
Order 4. Neurop'tera.
Ephemera; *Libellula*, dragon-fly.
Order 5. Lepidop'tera.
Butterflies and moths.
Order 6. Hymenop'tera.
Apis, bee; *Vespa*, wasp; *Formica*, ant.
Order 7. Dip'tera.
Œstrus, bot-fly; *Musca*, house-fly.
Order 8. Strepsip'tera, bee-parasites.
Stylops.
Order 9. Aphanip'tera (*Siphonaptera*; *Suctoria*).
Pulex, flea.
Order 10. Anoplu'ra.
Pediculus, louse.
Order 11. Thysanu'ra.
Lepisma, *Podura.*
Order 12. Myriap'oda.
Iulus, *Lithobius.*

Class IV. Annulata (*Anellida*).
Order 1. Setig'era.
Lumbri'cus, earthworm; *Nais*; *Tubifex*; *Aphrodita.*
Order 2. Sucto'ria.
Hirudo, leech.
Order 3. Turbella'ria.
Planaria.

Class V. Rotatoria (*Rotifera*).
Order 1. Rotato'ria.

Class VI. Entozo'a.
Order 1. Cestoi'dea, Tape-worms.
Tænia; *Bothriocephalus*, *Acanthocephalus* (*Cystica*, *Cysticercus*, *Echinococcus*, *Cœnurus.*)
Order 2. Trémato'da.
Dis'toma, fluke (*Cercaria*); *Gyrodactylus.*
Order 3. Acanthoceph'ala.
Echinorhynchus.
Order 4. Nematoid'ea.
Tricocephalus, *Filaria*, *Ascaris* (*Oxyuris*), *Anguillula*, *Gordius.*

Subkingdom IV. Radiata.

Class I. Echinoder'mata.
Order 1. A'poda.
Sipunculus, *Chirodota.*
Order 2. Pedicella'ta.
Asterias, star-fish; *Echinus*, sea hedgehog; *Ophiocoma*; *Spatangus.*

Class II†. Acalé'phæ, Medusæ. Sea-nettles.
Order 1. Discophora*.
Medusa, sea-nettle, jelly-fish; *Rhizostoma*, *Cyanæa*, *Thaumantias.*
Order 2. Ctenoph'ora.
Beroe.
Order 3. Siphonoph'ora*.
Physalis, Portuguese man-of-war.

Class III †. Pol'ypi (Zoophytes).
Order. 1. Anthozo'a.
Actinia, sea-anemone; *Gorgonia*, sea-fan; *Alcyonium.*
Order 2. Hydroi'da*.
Hydra, *Sertularia*, *Tubularia.*

†† These two classes are united by some authors to form the class Cœlenterata.
*** These three orders form the Hydromedusæ or Hydrozoa of some authors.

Subkingdom V. Protozoa.

Class I. Infusor'ia.

Class II. Rhizop'oda.
Order 1. Lobo'sa.
Amœba, *Arcella.*

Order 2. RADIOLARIA.
Actinophrys, Acineta; *Polycystina.*
Order 3. RETICULARIA.
Gromia, Foraminifera.

Class III. SPONGIDA.

BIBL. Rymer Jones, *Animal Kingdom*; Todd's *Cycl. of Anat. and Phys.*; Siebold and Stannius, *Lehrb. d. vergleich. Anat.*; D'Orbigny, *Dict. d'Histoire Nat.*; V. d. Hoeven, *Handbuch der Zoologie*; Owen, *Hunterian Lectures*; Carpenter, *Comparative Physiology*; Cuvier's *Animal Kingdom*, by Blyth, Mudie, Johnston, Carpenter and Westwood; the new edition of the *Règne Animal*; Vogt, *Zoolog. Briefe*; Gosse, *Marine Zoology*; Carus, *Ic. Zootomicæ* (*Invertebrata*); Blanchard, *L'Organis. du Règne Animal*; Leydig, *Lehr. d. Histol.*; Van Beneden, *Anat. Comparée*; Chenu, *Encycl. d'Hist. Nat.* (8000 figs.), 1866; Giebel, *Naturg. d. Thierreichs* (8000 figs.), 1865; Bronn, *Die Klassen und Ordn. d. Thierreichs*, 1859–67.

ANISONE'MA, Duj.—A genus of Infusoria, belonging to the family Thecamonadina.

Char. Body colourless, oblong, more or less depressed, covered with a resisting tegument, from an aperture in which two filaments emanate; one flagelliform and directed forwards; the other thicker, trailing and retracting the body of the animal; movement slow. 2 species:—

1. *A. acinus.* Movement directly forwards, colourless, aquatic; length 1-1280 to 1-810″.

2. *A. sulcata* (Pl. 23. f. 12). Movement vacillating in a circle; colourless, aquatic; length 1-1100″.

Dujardin suggests that the *Bodo grandis* of Ehrenberg is referable to one of these species, as also to the genus *Heteromita*, Duj.

BIBL. Dujardin, *Infusoires*, p. 345.

ANKISTRODESMUS, Corda.—A genus of Desmidiaceæ.

Char. Cells elongated, attenuated, entire, aggregated into faggot-like bundles.

The cells only differ from those of *Closterium* in their aggregation. Species:—

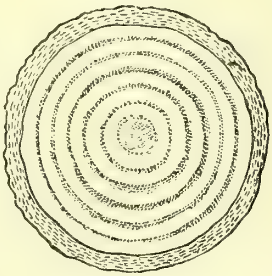
1. *A. falcatus*, Corda (*Rhaphidium fasciculatum*, Kütz.). Cells numerous, crescent-shaped: aquatic; length 1-549″, breadth 1-7353″; common. (Pl. 10. fig. 47.)

2. *A. fusiformis*, Corda. } Carlsbad.
3. *A. convolutus*, Corda. }

BIBL. Ralfs, *Brit. Desmidieæ*, pp. 179 and 222; Corda, *Almanach de Carlsbad*, 1835, p. 121; 1838, p. 199.

ANNUAL RINGS.—The concentric lines seen in transverse sections of Dicotyledonous stems (fig. 21) generally indicate

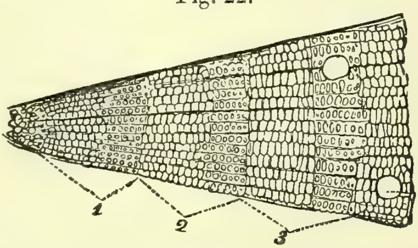
Fig. 21.



Cross section of a Dicotyledonous stem with annual rings.

successive annual additions to the woody structure, and in these cases depend on the difference of the character or condition of the tissues produced at different seasons. Ordinarily there are a number of ducts grouped near the inner part of each concentric layer of wood, as in the Oak. In the Sumach a layer of cellular tissue occurs at the boundary of each ring. In the Conifers, the markings result from the greater thickness of the secondary deposits on the walls of the cells in the outer part of each

Fig. 22.



Magnified cross section of stem of *Pinus*, exhibiting parts of three annual rings, 1, 2, 3.

layer, no ducts existing in their wood (fig. 22).

It seems that these rings cannot be taken strictly as annual rings in all trees, especially in those of equable climate, since they appear to depend upon external influences affecting the activity of vegetation; and thus, even in temperate climates, a great loss of foliage in the summer, followed by

recovery, may produce two rings in one year. In moist tropical climates, where the leaves reappear almost continuously, the rings probably answer to periods of great renewal of foliage.

ANNULATA, *Anellida.*—The class of red-blooded worms, &c.

Char. Elongated animals, living in water or moist earth, not parasitically within other animals; body usually jointed; feet not jointed, and frequently replaced by bristles or retractile setigerous tubercles. Respiration effected either by external branchiæ or by internal vesicles, or by the skin itself. Distinct organs of circulation present, contractile vessels replacing a heart. Nervous system consisting of a single or double ventral cord, furnished with ganglia at intervals, and encircling the œsophagus above.

The *skin* consists of a very delicate structureless and transparent epidermis, beneath which (in *Hæmocharis* (*Piscicola*), *Clepsine* and *Nephelis*), there is a layer of cells, which, in the adult animals, presents the appearance of a fenestrated membrane (Pl. 40. fig. 16). The cells (Pl. 40. fig. 16 *b*) leave spaces between them which appear like holes; but the addition of acetic acid brings to light in each space a distinct nucleus (Pl. 40. fig. 16 *c*), and in very young animals the clear spaces are distinct cells, distinguishable from the surrounding cells by their size and containing numerous clear vesicles as well as a nucleus. The smaller cells contain a nucleus and numerous nuclear granules. Beneath this cellular layer are numerous large fat-cells, pigment-cells and connective tissue, the latter consisting of a transparent, homogeneous, semisolid mass. A layer of fine but firm fibres, crossing each obliquely, is said to be sometimes met with beneath the epidermis and forming a corium or true skin.

In the Turbellaria, the outermost cutaneous layer consists of ciliated epithelium. The opalescent and often beautifully coloured skin of many of the Annulata does not generally owe its tints to distinct pigment, but to iridescence produced by the fibres.

The rings of the body are usually furnished with bristles or hairs, sometimes arranged in tufts, at others covering the greater part of the surface of the body.

The bristles are most exquisite objects for microscopic observation, displaying the greatest variety of form, constituting lances, spears, knives, saws, sickles, hooks, &c., of innumerable elegant shapes, often curiously jointed, and usually fashioned out of an elastic material that rivals the clearest glass (Gosse). Sometimes foliaceous appendages cover the body like scales. Most of the Annulata are covered with a kind of mucus, secreted by the cutaneous glands; some live in leathery tubes or sheaths; in others a case is made by the consolidation of the secretion from some part of the skin with fragments of shells, grains of sand, &c.; in others, again, the calcareous tubes appear to be wholly secreted by a portion of the cutaneous surface.

The *muscular system* is usually well developed. The muscular fibres are in some arranged in three layers, an outer consisting of annular, an inner of longitudinal, and an intermediate of oblique fibres; in others there is an outer layer of oblique fibres, an inner of longitudinal, with annular fibres at the two ends of the body. The muscular fibres consist of cylinders, the transverse section of which is rounded (Pl. 40. fig. 17 *a*), flattened or incurvated (Pl. 40. fig. 17 *b*). They are covered externally by a delicate sheath or sarcolemma (Pl. 40. fig. 18 *b*). The cylinders themselves consist of a clear, homogeneous, cortical substance (Pl. 40. fig. 18 *a*), and an internal cavity (*c*), the latter being filled with a finely granular substance, in which scattered nuclei are imbedded (Pl. 40. fig. 17 *c*). At the two ends of the body, the muscular fibres branch dichotomously (Pl. 40. fig. 19 *c*). The fibres are usually smooth, but sometimes longitudinally or transversely striated; this appearance arising either from folds in the sarcolemma or proper sheath, or from the granules being arranged in linear series.

In the Turbellaria, the muscular system is but slightly developed, the tissue beneath the skin consisting of globular masses resembling the general parenchyma of the body; and in this, peculiar cellular bodies are often imbedded, resembling the urticating organs of the polypes. These enclose six, eight, or more rod-shaped bodies, which are sometimes parallel with each other, sometimes somewhat spirally curved. The cell-membrane of these bodies subsequently disappears, and they frequently project beyond the skin. Leydig figures similar rod-shaped bodies as occurring in the nuclei of the fat-cells situated beneath the skin.

In many of the Annulata, the muscular fibres are grouped into distinct bundles,

serving to move the bristles, parts of the mouth, &c.

Beneath the skin at the ends of, or all over the body, a number of peculiar glands exist; these consist at the closed end of a nucleated cell (Pl. 40. fig. 19 *b d*), and a long, somewhat coiled duct opening at the surface of the body.

The *nervous system* consists of a longitudinal, single or double series of ventral ganglia, connected by longitudinal cords; the uppermost ganglion lies above the œsophagus, and the two cords which connect it with the second ganglion encircle this organ. In some, the ventral ganglia are absent.

The uppermost ganglion is enveloped in a neurilemma consisting of longitudinal and transverse fibres, and not unfrequently peculiar pigment-cells. The cords and filaments are composed of extremely delicate primitive fibres, between which, in the ganglia, ganglion-globules are situated. The filaments distributed to the body arise principally from the ganglia.

Many of the Annulata are furnished with eyes; these are usually denoted by the brown, black or red spots seen upon various parts of the body. It is a disputed point whether all these represent true eyes or not; but Quatrefages has described a lens, transparent cornea and vitreous humour in some of them, and he has no doubt that the red points found at the sides of each ring in several species of *Nais* are true eyes.

In some Annulata, no distinct head is present; in others this is distinguishable by its form, and is furnished with eyes and one or more filaments, which are regarded as antennæ. In those in which the head is not distinct, the mouth is situated at the anterior end of the body; in the others the mouth is on the ventral surface, and is furnished with a muscular proboscis. The mouth is usually surrounded by turgid lips, and sometimes possesses a distinct dental armature (see HIRUDO). The oral aperture is frequently surrounded by a number of erectile tentacles or cirri.

The intestinal canal is usually straight, and furnished with lateral appendages, or constricted at intervals; sometimes a separate œsophagus, stomach and intestine are distinguishable. The inner, and sometimes the outer surface of the alimentary tube is covered with ciliated epithelium. A yellow or brown glandular layer surrounding the alimentary canal represents the liver.

The general arrangement of the *circulatory system* is, that two main vascular trunks, one dorsal, the other ventral, traverse the body longitudinally; and the blood moves in the dorsal vessel from behind forwards, whilst in the abdominal vessel it moves from before backwards; these trunks being connected by transverse vessels or meshes of them. The anterior portion of the dorsal vessel is usually broader, and appears to form the rudiments of a heart.

The *respiration* of the Annulata is effected either by the skin; by external gills in the form of tentacular filaments or tufts, sometimes ciliated; by ciliated depressions, or by vesicles at the sides of the body. The internal convolute ciliated canals, or water-vessels, which were formerly considered respiratory organs, are now regarded as secretory tubes. In many instances a transparent colourless liquid occupies the interstices between the skin and the organs of the body; this contains colourless (rarely coloured) corpuscles much resembling the colourless corpuscles of the Vertebrata; and in this lie coils of vessels containing the coloured blood. The colourless liquid is the "chylaqueous fluid" of Dr. Williams.

The Annulata are propagated by transverse division, by gemmation, and by means of sexual organs. The embryos are at first minute, rounded, and partially covered with vibratile cilia.

Order 1. TURBELLARIA. Body bilateral, soft, covered with vibratile cilia, not segmented; eyes distinct; sexless or hermaphrodite.

Order 2. SUCTORIA (APODA). Body elongate, ringed, without bristles or foot-like tubercles; locomotion by sucking-disks; no external branchiæ.

Order 3. CHÆTOPODA (SETIGERA). Body ringed, elongate, with feet or setigerous rudiments of them; external branchiæ usually present.

BIBL. Siebold, *Lehrb. d. vergl. Anat.* i.; Jones, *Animal Kingd.*; V. d. Hoeven, *Handb. d. Zool.* i.; Milne-Edwards, *Todd's Cyc. of Anat. &c.*; Leydig, *Lehrb. d. Histol.*; Johnston, *Brit. Anellida*; Gosse, *Mar. Zool.* i.; Vogt, *Zool. Briefe*; Claparède, *An. Chétopod.* (*Qu. Micr. Journ.* 1869, p. 306); id. *Ann. Nat. Hist.* 1867, xx. p. 337; Ehlers, *Die Borstenwürmer*, 1869; Agassiz, *Ann. Nat. Hist.* 1867, xix. p. 242; Quatrefages, *Suites à Buffon*; Gegenbaur, *Vergl. Anat.* 1870, p. 155.

AN'ODUS, Br. & Sch. = SELIGERIA.

ANŒCTANGIUM, Br. & Sch.=ZYGODON.

ANOMAL'INA, D'Orb.—With some exceptions (as *An. elegans*, D'Orb., which is a small *Discorbina*) the *Anomalinæ* are somewhat biconvex *Truncatulinæ*, neat, discoidal, and subnautiloid, with nearly as much convexity of the chambers on the lower as on the upper side of the shell. Abundant, both recent and fossil.

BIBL. D'Orb., *For. Foss. Vienn.* p. 169; Carpenter, *Introd. For.* p. 208.

ANOMALO'CERA, Temp.—A genus of Entomostraca, of the order Copepoda and family Diaptomidæ.

Char. Head distinguishable from the body, with a bifid beak and a hooked spine at the base on each side; thorax with six, abdomen with four segments; foot-jaws three pairs; last pair of legs differing from the others; eyes single, pedunculated in the male; right superior antenna with a swollen hinge-joint (in the male); inferior antennæ not branched, three-jointed, basal joint with a slender twig. 1 species:—

A. Patersonii (Pl. 14. fig. 6, the male). Marine.

BIBL. Baird, *Brit. Entomostr.* p. 229; Templeton, *Trans. Entom. Soc.* vol. ii. 1837.

ANOM'ODON, Hook and Taylor. See NECKERA and HYPNUM.

ANOPLU'RA.—An order of Insects; sometimes termed Parasitica or Epizoa.

Char. Legs six; wings none; parasitic, and not undergoing metamorphosis; eyes two, simple, or none.

These insects are parasitic upon mammals and birds, and are commonly known as lice. The order is thus subdivided:—

Subord. 1. HAUSTELLATA (RHYNCHOTA). Mouth with a tubular, very short fleshy haustellum.

Fam. 1. PEDICULIDÆ. Antennæ five-jointed.

Gen. *Phthirius.* Anterior legs for walking, posterior for climbing.

Pediculus. Legs all for climbing; abdomen of seven segments.

Hæmatopinus. Legs all for climbing; abdomen of eight or nine segments.

Subord. 2. MANDIBULATA (MALLOPHAGA). Mouth with two horny mandibles.

Fam. 2. PHILOPTERIDÆ. Antennæ filiform, maxillary palpi none.

Philopterus. Antennæ five-jointed; tarsi two-jointed, claws two.

Trichodectes. Antennæ three-jointed; tarsi two-jointed; with one claw.

Fam. 3. LIOTHEIDÆ. Antennæ clavate; maxillary palpi conspicuous.

Liotheum. Tarsi two-jointed, with two claws.

Gyropus. Tarsi two-jointed, with one claw.

It appears that although the Anoplura do not undergo metamorphosis as in the more perfect insects, consisting of larva, pupa and imago, widely differing from each other in general appearance, habits and functions, yet a series of semitransformations takes place in the shedding of the skin a definite number of times, by which the individual acquires a greater symmetry of form, and most probably a greater perfection of parts or organs.

BIBL. Nitzsch, *Germar and Zincken's Mag. d. Entomol.* iii.; Burmeister, *Gen. Insect.*; Leach, *Zool. Miscellany*, iii.; Gurlt, *Mag. f. d. Ges. Thierheilkunde*, viii.; Denny, *Monogr. Anoplur. Brit.*; id. (*Chinese*), *Qu. Mic. Jn.* 1864, p. 18; Walckenaer, *Hist. d. Insect.* xiii.; Landois, *Sieb. & Köllik. Zeits.* 1865 (*Qu. Mic. Journ.* 1866, p. 34).

ANOURELLA, Bory and Duj. = ANURÆA, Ehr.

ANTEN'NÆ, of Insects.—The two moveable-jointed organs situated on the head, near the eyes (Pl. 26. figs. 1 *a*, 3 *a*, 24 *a*, and figs. 7 to 21 inclusive).

The form, number of joints, &c. of the antennæ are used as characters for distinguishing the genera and species of Insects.

Three parts are generally recognizable in the antennæ: 1, the *scapus* or basal joint (figs. 10, 18, and 19 *a*) is often very long, and is connected with the *torulus*, or part upon which it moves, by a ball and socket articulation; 2, the *pedicella* or second joint (the same figs., *b*), which is mostly minute and nearly spherical, allowing of the freest motion, and supporting the remaining portion of the antenna, which forms, 3, the *clavola* (figs. 10 and 18 *c*). The principal terms applied to the antennæ according to the form and arrangement of the joints of the clavola are these:—

They are called *setaceous* when the successive joints gradually diminish in size from the base to the apex, as in the families Achetidæ, Blattidæ, and Gryllidæ (fig. 7); *ensiform* when the successively diminishing joints are angular at the sides, forming a sword-like organ, as in some of the Locustidæ (fig. 8); *filiform* when all the joints of the clavola are of uniform thickness, as in the Carabidæ (fig. 9); *moniliform* when the

joints are spherical or rounded, as in the Tenebrionidæ and Blapsidæ (fig. 10); *serrated* when the joints appear like inverted triangles, with the inner margin more produced than the outer, as in some of the Elateridæ (fig. 11); *imbricated* when the acute base of each joint is inserted into the middle of the broad apex of the joint behind it, as in the Prionidæ (fig. 12); *pectinated* when each joint is developed on one side into a process or spine, as in the Lampyridæ (fig. 13); *bipectinated* when a process or spine exists on each side of the joints, as in the Bombycidæ (fig. 14); *flabellate* when each of the processes is flattened, and nearly as long as the whole of the succeeding joints taken together, as in some of the Elateridæ (fig. 15); *clavate* when the clavola ends in a gradually formed knob (fig. 16), or *capitate* when the knob is suddenly formed (fig. 17), as in the Pentamerous Coleoptera; *plumose* when one or more minutely pectinated branches arises from the joints, as in some of the Muscidæ (fig. 20), or when tufts of capillary filaments arise from the joints, as in the Culicidæ (fig. 21); *lamellate*, as in the lamellicorn Coleoptera, when the knob is composed of a number of lamellæ or plates (fig. 18 *d*), and *perfoliate* when the joints of the knob are separated slightly from each other by a minute foot-stalk. There are many curious variations in the structure of the antennæ; thus, in some of the Muscidæ, the filamentous portion represents the true clavola, while the larger lobe is simply an appendage (fig. 20); in *Globaria Leachii* the pedicella is not a small rounded joint, but is elongated like the scapus (fig. 19 *b*), whilst the clavola (*c*) ends in a large capitulum, attached laterally to the base of the fifth joint, and directed backwards.

The use of the antennæ is that of hearing or feeling the vibrations of the atmosphere. Braxton Hicks has pointed out the existence in numerous insects of minute cavities or pits in the surface of the antennæ, furnished with a nerve-branch at the base, to which this function is attributable; an additional function in many insects being that of common feeling or touch.

Hicks recommends the use of an aqueous solution of chlorate of potash, acidified with muriatic acid, for bleaching the chitine, and rendering these organs distinguishable.

Bibl. Kirby and Spence, *Introd. to Entomology*; Burmeister's *Manual, &c.*, transl. by Shuckard; Newport, Art. *Insects*, Todd's *Cycl. Anat. and Phys.* ii.; Westwood's *Introduc. &c.*; Hicks, *Linn. Trans.* 1859, xxii. pp. 147 & 383; Claparède, *Ann. d. Sc. Nat. Zool.* 1858, x. p. 236.

ANTENNA'RIA, Link.—A supposed genus of Antennariei (Physomycetous Fungi), referred by Fries to Perisporiaceæ, and probably often forms of a Mucedinous state of Capnodium. They are byssoid products growing upon dead or living structures, or sometimes in cellars. *A.* (*Racodium*) *cellaris*, the fungus of wine-cellars, is placed by Fries in the genus Zasmidium.

ANTENNARIE'I.—A supposed tribe of Physomycetous Fungi, consisting of diffuse plants, forming flocculent or byssoid patches upon leaves or bark, which appear to be merely states of other genera; the epiphytic *Antennariæ* are referred to *Capnodium*, which, like *Zasmidium* (*Antenn. cellaris*), is a Perisporiacea. Two other genera, *Pleuropyris* and *Pisomyxa*, were described by Corda, but little is known respecting them.

Bibl. Fries, *Summa Veg. Scan.* p. 406; Berkeley, *Crypt. Bot.* p. 296.

ANTENNULA'RIA, Lamk.—A genus of Polypes, of the order Hydroida, and family Sertulariadæ.

Distinguished by the whorled, hair-like branchlets, and uniserial cells. Two British species:—

A. antennina. Main stalks simple, clustered, branchlets short. On sandy soils and stones lying in sand; deep water.

A. ramosa. Main stalks branched. On old shells and stones from deep water.

Bibl. Johnston, *Brit. Zooph.* 85; Gosse, *Mar. Zool.* i. 24; Hincks, *Brit. Zooph.* p. 279.

ANTHER.—The essential part of the male or fertilizing organ of Flowering Plants, supported on a longer or shorter stalk or *filament*, and constituting with it the *stamen*. The microscopic examination of anthers turns in two distinct, both very interesting directions, namely, study of the development and characters of the pollen produced in the anthers, and examination of the cellular structure of the walls of the perfect anther. For the former, see Pollen.

The cells of the anthers of almost all plants exhibit deposits of a more or less fibrous character, varying much in the patterns according to which the fibres are placed, and the extent to which they are developed; and these are elegant microscopic objects.

The anther is clothed with a very delicate epidermis, sometimes provided with sto-

mata; this epidermis usually remains unaltered, but in some cases (*Lupinus*) the walls acquire fibrous thickening. Beneath this epidermis ordinarily lie one or more layers of cells which form the spiral-fibrous tissue. This may extend all round the anther, or be wanting at certain points, especially over the connective, before and behind; sometimes all the cellular tissue of the connective itself assumes the same character (with the exception of its vascular bundle).

Purkinje has furnished a most extensive notice of the conditions of these fibrous cells in the different families of Flowering Plants. The following plants are selected as affording considerable diversity of forms:—

a. Spiral fibres. *Narcissus poeticus, Populus alba, Lonicera tartarica, Hyoscyamus orienta'lis, Datura Stramonium, Cheiranthus Cheiri* (Pl. 32. fig. 1).

b. Annular fibres. *Iris florentina, Hyacinthus orientalis, Bunias orientalis, Cheiranthus Cheiri, Convallaria.*

c. Reticulated fibres. *Fritillaria imperialis* (on the internal face), *Tu'lipa Gesneriana* (ditto), *Viola odorata* (ditto), *Saxifraga umbrosa* (Pl. 32. fig. 2).

d. Fibres arched (found on three sides of the walls, the fourth being free). *Nuphar lutea, Bryonia dioica, Cynoglossum, Pulmonaria, Primula sinensis, Passiflora cærulea, Ligustrum vulgare, Cucurbita, Pyrus, Lupinus* (Pl. 32. fig. 3).

e. Fibres short and straight, pieces upon the walls standing vertically to the epidermis. *Arum, Calla æthiopica, Calceolaria, Delphinium, Anemone.*

f. Like *d,* but converging towards the centre of the upper wall of the cell, sometimes forming a star. *Corydalis lutea, Impatiens, Fumaria, Cactus* (Pl. 32. fig. 4), *Polygonum, Tropæolum majus, Veronica perfoliata, Polygala Chamæbuxus, Rubia tinctorum, Armeria.*

g. Fibres vertical, very short, numerous and close, like teeth on the walls. Grasses, *Casuarina, Myosotis, Phlomis fruticosa, Robinia, Adonis vernalis, Glaucium luteum, Chelidonium majus, Magnolia, Liriodendron, Dahlia, Leontodon, Solidago, Bellis perennis* (Pl. 32. fig. 5), *Geranium, Pelargonium, Pinus, Cupressus, Juniperus.*

h. The walls simply thickened like wood-cells. *Zamia.*

Other intermediate mod fications exist; and it is necessary to observe that the character of the markings often differs in different parts of the wall of the anther. The side of the cell-wall next the cavity is that generally most marked; the outer wall lying next under the epidermis is often smooth and unmarked.

A similar structure is found on the walls of the sporanges of many of the Hepaticæ, such as *Marchantia* (Pl. 32. fig. 35), *Jungermannia,* &c. (see HEPATICÆ). Also on the walls of the sporanges of *Equisetum* (see EQUISETACEÆ). For further particulars respecting the relations of these cells to other spiral-fibrous tissues, see SPIRAL STRUCTURES.

BIBL. Purkinje, *De cellulis antherarum fibrosis*, Wratislaviæ, 1830.

ANTHERID'IA.—The general name applied to all the various structures in which, certainly or probably, the fertilizing function of reproduction resides in Flowerless Plants, and which consequently correspond physiologically to the anthers of the Flowering Plants. They differ to some extent in the character of the final products, which are extremely minute bodies, some exhibiting spontaneous motion when placed in water.

The antheridia of the higher Flowerless Plants, those with leaf and stem, produce active filaments, coiled more or less in a spiral form, and the motion is here connected with the presence of cilia upon the spiral filaments. With regard to those of the Thallophytes, the antheridia are not everywhere so well understood. Their existence is clearly ascertained in the Fucaceæ, and the active bodies are ciliated. The function of the so-called antheridia of the Florideæ is not yet proved, and it is denied by Thuret that the antherozoids (or spermatozoids) have a power of motion; recent researches among the Confervaceæ have shown the existence of antheridial cells, producing active spermatozoids, to be very general in that order. In the Fungi and Lichens the antheridia seem to be represented by a different kind of structure, which produces minute stick-shaped bodies, apparently not endowed with spontaneous motion.

The moving bodies from the antheridia are called *spermatozoids, antherozoids,* or *spermatic filaments* in the higher Cryptogamia. The active bodies of the Fungi and Lichens have been provisionally named *spermatia.*

The antheridia of the Marsileaceæ are represented by the smaller form of spore produced in the sporanges (see MARSILEACEÆ). This is also the case in regard to the Lycopodiaceæ so far as *Selaginella* and *Isoëtes*

are concerned (see LYCOPODIACEÆ). In the Ferns and Equisetaceæ the antheridia are produced along with the archegonia on the prothallium or cellular frond resulting from the germination of the spore (see FERNS and EQUISETACEÆ). In the Mosses and leafy Liverworts, the antheridia are produced in terminal or axillary buds, associated with or separate from the archegonia (fig. 23). In the frondose Liverworts, they are imbedded in the frond, or more or less raised from it on special receptacles (see MOSSES and HEPATICÆ).

Fig. 23.

Bartramia fontana. Male inflorescence with antheridia and paraphyses. Magnified 40 diameters.

The antheridia are represented in Characeæ by the so-called globule, in which are produced filamentous spermatozoids resembling those of Mosses (see CHARA).

Antheridia occur in Saprolegniæ (Pringsh. *Jahrb.* Bd. vi. p. 249 &c.; *Tab. Fungi,* fig. 26), and have been observed in *Tuber* and *Peziza.* (See Pringsh. *Jahrb.* Bd. ii. p. 378 &c.; De Bary, *Ann. d. Sc. Nat.* Juin 1866, p. 343; Tulasne, *Ann. d. Sc. Nat.* Déc. 1866, p. 211.)

The supposed antheridial organs of the Lichens are called *spermogonia,* and will be found described under LICHENS; and the analogous structures found in certain Fungi called by the same name, are described under CONIOMYCETOUS FUNGI, also under the heads of certain genera of that family. The antheridia of the Algæ are described under FUCUS, FLORIDEÆ, ŒDOGONIUM, VAUCHERIA, SPHÆROPLEA, VOLVOX.

ANTHEROZOIDS.—The term applied by the French authors to SPERMATOZOIDS.

ANTH'INA, Fries.—A genus of Isariacei (Hyphomycetous Fungi), composed of minute fibrous plants, often of bright colours, growing upon dead leaves &c. in autumn. One British species is recorded:—

A. flammea, Fr. Attenuated downwards, smooth, crimson-saffron, dilated upwards, feathery, yellow. *Clavaria miniata,* Purton. A beautifully coloured Fungus, varying as to the degree of ramification, scarcely 1-2‴ thick at the base; thickened upwards, as also are the branches; fibrous and feathery at the summit; solitary; from 1-2″ to 1″ high; turning blackish when dried. The spores separate very readily when the specimens are placed in water for examination.

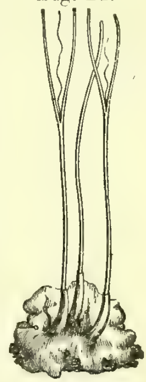
It may, however, be doubted whether even *Anthina flammea,* which occurs occasionally in considerable quantity amongst dead leaves in shady woods, is an autonomous fungus, though it may be difficult to point out of what species it may be a state, unless it be related to *Thelephora multizonata,* Berk.

BIBL. Purton, iii. t. 18; Nees and Henry, *System der Pilze,* 1837, t. 6; Fries, *Summa Veget.* p. 465.

ANTHO'CEROS, Mich.—A genus of Anthoceroteæ (Hepaticæ).

The forms found in Britain are regarded by Hooker as varieties of one species. By the continental botanists they are divided into two: *A. punctatus,* with the frond dotted and divided at the margin; and *A. lævis,* with the frond smooth (fig. 24).

Fig. 24.



Anthoceros lævis. Magnified 2 diameters.

These plants are found in very moist situations, at the sides of ditches &c., fruiting in spring. The ovate-oblong fronds are from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch long, lying flat, and often forming round patches, overlapping one another, radiating from a centre, and more or less divided at the margin. The texture is between membranaceous and fleshy, inclining to the latter; the colour deep green, lighter at the margins. The antheridia and archegonia are usually abundant on the same individual. The antheridia are spherical, with short stalks, of a yellowish-orange colour, included in cup-shaped, deeply toothed receptacles on the upper face of the fronds. The young archegonia differ from those of any other Hepaticæ in their structure, since, instead of free, flask-like cases, they are tubular cavities running down from the upper face of the frond, with an embryonal cell at the bottom, which increases by degrees into a conical body, and finally emerges on the surface, surrounded by a perichæte continuous with the epidermis of the frond. The conical body by degrees grows up into the narrow pod-like sporange, which attains a length of about 2 inches, and is supported on a short pedicel, 2 to 3 lines high, almost concealed in the perichæte. The sporange splits down the middle into two valves, which

become slightly twisted, and leave in the centre a thread-like column, to which adhere for a time many of the spores and elaters. The spores,—the development of which has been a subject of much study, and is very instructive,—from the long sporange containing specimens of successively older formation from one extremity to the other,—are of the ordinary character of these tribes, having a reticulated outer coat, marked by ridges indicating the mutual pressure of the four spores formed in each parent-cell. The elaters are much simpler than usual, consisting merely of membranous tubes, not very long, but sometimes irregularly curved or branched, without any spiral fibre in their interior. Gemmæ also occur on the frond of *Anthoceros*.

BIBL. Dev. of the Fruit generally: Hofmeister, *Vergleich. Unters. Höhern. Kryptogamen*, Leipsic, 1851; Schacht, *Entw. der Frucht und Spore von Anthoceros lævis, Botanische Zeitung*, 1850. Spores: Mohl, *Linnæa*, 1839; *Vermischte Schrift.*, Tübingen, 1846; Nägeli, *Mem. on Veget. Cells, transl. in Ray Society's Reports and Papers on Botany*, 1846 (p. 229), from Schleiden and Nägeli's *Zeitschr. für wiss. Botanik.*

ANTHOCEROTEÆ.—A tribe of Liverworts or Hepaticæ (which see), containing one British genus, ANTHOCEROS.

ANTHO'PHORA, Latr.—A genus of Insects, of the order Hymenoptera, and family Apidæ.

Char. Wings with three complete submarginal cells of equal size; labial palpi with the third joint affixed obliquely; maxillary palpi 6-jointed; intermediate legs of male with long brushes of hair.

There are two species, *A. retusa* and *A. Haworthana.*

A. retusa (mason bee) is commonly seen flying about sunny and sandy banks from March to the beginning of June. Its head and trophi are represented in Pl. 26. fig. 24.

The *antennæ* (*a*) are inserted in the centre of the face, not approximating, short, geniculated, and 13-jointed in the male; basal joint (scapus) very pubescent, second (pedicella) globose, third as long as the first, fourth shorter than any of the following, which are oblong; they are similar in the female, but a little longer, and 12-jointed. *Labrum* (*e*) deflexed, convex, with two black spots at the base, anterior margin a little convex and ciliated. *Mandibles* (*f*) slightly curved, clothed with long hairs, notched near the apex; larger in the females, and but slightly notched below the apex. *Maxillæ* (*g*) with the basal portion short and broad, hairy, the edge above pectinated, terminal lobe long and lanceolate, with a small pencil of hairs at the apex. *Palpi* (*h*) rather long and setaceous, 6-jointed, basal joint short, second long, the remainder decreasing in length. *Mentum* rather short and linear. *Tongue* (*) very long and slender, ringed and tubular, the interior margins very pilose, terminated by a lanceolate appendage. *Paraglossæ* (*x*) lanceolate. *Palpi* (*k*) extending as far as the tongue, slender, tapering, 4-jointed, basal joint very long, second not half the length, ciliated towards the apex, third inserted below the apex, and very small, as well as the fourth. Head subtrigonate; eyes (*c*) long and narrow; ocelli (*b*) three. Thorax much broader than the head in the female. Legs rather robust; tibiæ, posterior dilated and very pilose externally, and the intermediate ones also in the females; tarsi, intermediate pair long in the males, the basal joint of the 4 posterior dilated in both sexes, and furnished with a strong brush at the apex in the hinder pair of the female. Claws bifid in the males, with a tooth on the underside in the female. Pulvilli distinct. Male thickly and minutely punctured, and clothed with fulvous or yellowish hairs, more or less black at the apex of the abdomen; female black, very pilose. See INSECTS.

BIBL. Curtis, *British Entomology*, viii. p. 357; Westwood, *Introduction*, &c., ii. p. 277.

ANTHOPHY'SA, Duj.—A genus of Infusoria, of the family Monadina (Duj.).

Char. Animals ovoid or pyriform, with a single anterior flagelliform filament, and aggregated at the ends of the branches of a support or polypidom, which is secreted by them. The groups, when free, resemble *Uvella*, and revolve in the liquid containing them.

The branched support is of an irregular arborescent form, at first soft and glutinous, afterwards becoming brownish, horny, and nodular in appearance. According to Cohn, the brownish filaments so frequently found in decomposing pond- &c. water, are the stalks of *Anthophysa*, and form Kützing's genus *Stereonema.*

A. Mülleri (Pl. 23. fig. 13). Body thicker in front; aquatic; length of stalks 1-250 to 1-120", length of single animal 1-2600". Fig. 13 *b* represents a detached animal with its flagelliform filament. This is the *Epistylis*

vegetans of Ehrenberg. The detached groups of bodies form a species of *Uvella*, Ehr. (*Uvella uva?*).

Bibl. Dujardin, *Infus.*; Ehr. *Infusionsth.*; Cohn, *Nova Acta*, 1854, p. 109; *Ann. N. Hist.* xviii. 1866, p. 429.

ANTHOSO'MA, Leach. — A genus of Crustacea, of the order Siphonostoma, and family Ergasilina.

Found upon the gill-covers and gills of sharks.

Bibl. Baird, *Brit. Entom.*; Desmarest, *Cons. génér. sur l. Crustac.*

ANTIGRAMMA, Presl.—A genus of Asplenieæ (Polypodioid Ferns). Exotic.

ANTIMONIATE of soda.—The production of this salt by the addition of antimoniate of potash to a neutral or alkaline solution of a salt of soda, is used as a test of the presence of soda. The crystals are represented in Pl. 6. fig. 21.

Bibl. See Chemistry,

ANTIMONY. See Arsenic.

ANTITRICHIA, Br. and Sch. = Neckera.

ANT'LIA.—The spiral tongue or proboscis of the Lepidoptera.

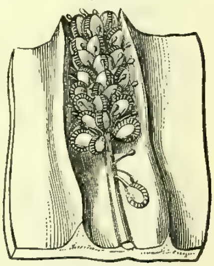
This well-known beautiful organ (Pl. 26. fig. 28), when extended, forms a long suctorial tube, and when coiled up represents a flat spiral, like the spring of a watch. It consists mainly of two modified maxillæ (see Insects). According to Mr. Newport, each maxilla is composed of an immense number of short transverse muscular rings; these are convex externally and concave internally, and the two connected organs form a tube. Within each there are one or more large tracheæ (fig. 28 *c**‡) connected with the tracheæ in the head. The inner or concave surface which forms the tube (fig. 28 *c*†) is lined with a very smooth membrane, and extends along the anterior margin throughout the whole length of the organ. At its commencement at the apex (fig. 28 *f**), it occupies nearly the whole breadth of the organ, and is smaller than at its termination near the mouth, where the concavity or groove does not occupy more than about 1-3rd of the breadth. In some species, the extremity of each maxilla is furnished along its anterior and lateral margin with a great number of minute papillæ. These, in *Vanessa Atalanta* (the red admiral butterfly) for instance, form little barrel-shaped bodies (fig. 28 *b, a, f*), furnished at the free end with three or more marginal teeth, and a larger pointed body in their centre. There are seventy-four of these in each maxilla, or half the proboscis. Newport regards them as probably organs of taste. There are also some curious appendages arranged along the inner anterior margin of each maxilla, in the form of minute hooks, which, when the proboscis is extended, serve to unite the two halves together, by the points of the hooks in one half being inserted into little depressions between the teeth of the opposite side; sometimes these are furnished with a tooth below the apex (fig. 28 *e*).

This description of the structure of this interesting organ does not appear to be correct. We believe that the older view, regarding each half of the Antlia as containing a distinct canal, to be true, and that the transverse rings, in fact the entire frame-work of the organ, consists of chitine. But the subject requires further investigation. The only muscular structure we have detected in the organ, consists of bundles of muscular fibres taking an oblique longitudinal direction.

Bibl. Newport, *Todd's Cycl. of Anat. and Phys.* ii. p. 901; Hicks, *Linn. Trans.* 1860, xxiv. p. 148. See also Insects.

ANTRO'PHYUM, Kaulf.—A genus of Grammiteæ (Polypodioid Ferns), with the sori imbedded in a kind of groove along the backs of the veins. Exotic.

Fig. 25.



Antrophyum Lessoni. Part of a sorus. Magnified.

The annexed magnified figure (fig. 25) represents part of a sorus, with some of the *thecæ* or sporanges *in situ*, sunk, as it were, in the surface of the leaf.

ANURÆ'A, Ehr.—A genus of Rotatoria, of the family Brachionæa.

Char. A single (red) eye-spot at the back of the head, no foot or pediform tail.

In seven species the back of the carapace is furnished with facets, in four with longitudinal striæ, in three it is smooth; in thirteen it is furnished with teeth or spines in front, in seven also behind. One species, *A. biremis*, has two moveable spines on each side.

Dujardin gives the following characters. Carapace in the form of a depressed utricle or sac, toothed in front and with a wide

orifice to allow of the protrusion of the rotatory organs, which are usually well developed in the form of two rounded lobes, accompanied by setæ or non-vibratile cilia in several bundles; no tail; jaws digitate; a red eye-spot above the jaws; ova voluminous, often adherent to the parent.

The species are both aquatic and marine, and many of them are common in pure fresh water; length from 1-240 to 1-120''.

Ehrenberg describes 14 species; to which Gosse adds 4.

A. curvicornis, E. (Pl. 34. fig. 5, viewed from above; fig. 6, side view).

Bibl. Ehr. *Infus.*; Duj. *Infus.*; Gosse, *Ann. Nat. Hist.* 1851, viii. p. 202.

ANYS'TIS, Heyd. (*Erythræus*, Dugès; *Trombidium*, Herm.).—A genus of Arachnida, of the order Acarina, and family Trombidina.

Char. Palpi large, free, bi-unguiculate; mandibles unguiculate; body entire; legs at their insertion contiguous, cursorial, *i. e.* unguiculate, long, the last joint slender and very long; posterior legs the longest.

1. *A. parietinum.* Colour vermilion; legs pale. Found between stones and in moss; and on book-shelves. *Tromb. parietinum*, Herm. *Mém. Aptérol.* p. 37, pl. 1. f. 12.

2. *A. ruricola.* Body very minute, depressed, nearly oval, slightly emarginate at the sides, and broader behind than before; a few hairs scattered over the surface; eyes two, black, placed at the anterior obtuse angles of the body; colour bright carmine, sometimes blackish in the middle, paler along the back and in front; legs and palpi colourless, except a bright red spot on each at a little distance from the body. On stones and on dry paths. (Pl. 41. fig. 4, and Pl. 2. fig. 3.)

3. *A. flava.* Yellow.

4. *A. ignipes.* Mottled with greyish brown and yellowish red.

5. *A. cursoria.* Rose colour.

6. *A. cornigera.* Red with two blackish lines down the back.

Bibl. Hermann, *Mém. Aptérol.*; Dugès, *Ann. d. Sc. Nat.* 2 sér. i. and ii.; Koch, *Deutsch. Crust.* &c.; Heyden, *Isis*, 160; Gervais, *Walckenaer's Hist. d. Insectes*, iii.

APHANIZOM'ENON, Morren (*Limnochlide*, Kützing).—A genus of Nostochaceæ (Confervoid Algæ) forming a delicate bluish-green mucous stratum on the surface of lakes or standing water. The filaments are very slender, flaccid and obscurely jointed. The spermatic cells are much elongated, either scattered or, more frequently, solitary near the centre of the filament. Allman inclines to think they are formed by confluence of adjacent cells; he found vesicular cells (heterocysts) also, which Ralfs did not describe. This genus seems to form a connecting link between the Oscillatoriaceæ and Nostochaceæ, as indicated by Hassall. Ralfs enumerates three British species, viz.—

1. *A. Flos-aquæ*, Linn. (Pl. 4. fig. 1).—Filaments about 1-3000'' in diameter, cohering laterally in flat lamellæ which separate at their extremities into fasciculi; spermatic cells cylindrical, with an inconspicuous covering.—Ralfs, *Ann. Nat. Hist.* 1850, v. pl. 9. fig. 6; *Limnochlide Flos-aquæ*, Kütz. *Tab. Phycolog.* cent. i. pl. 91. fig. 2 *a*.

2. *A. cyaneum*, Ralfs. Filaments free, aggregated into a thin mucous stratum; sporangia linear, 8 to 12 times longer than broad, with a conspicuous hyaline covering. —Ralfs, *l. c.* pl. 9. fig. 7. *Limnochlide Flos-aquæ*, var. *hercynica*, Kütz. *Tab. Phycolog.* cent. i. pl. 91. fig. 11?

3. *A. incurvum*, Morren. "Filaments articulated, cohering together in flat laminæ, laciniated at the apex; articulations 2 to 8 times longer than broad." Ralfs states that the Irish specimens identified by Morren do not agree with this character, being held together by the mucous matrix rather than cohering, as in *Flos-aquæ*, and they are neither fasciculated nor laciniated at the ends.—Ralfs, *l. c.* pl. 9. fig. 8. *Aph. incurvum*, Thompson, *Ann. Nat. Hist.* v. 82; Hassall, *Brit. Freshw. Algæ*, t. 76. fig. 6. *Limnochlide Flos-aquæ*, var. *Harveyana*, Kütz. *Tab. Phycolog.* cent. i. pl. 91. fig. 2.

Bibl. Ralfs, *Ann. Nat. Hist.* v. 339, 1850; Allman, *Qu. Mic. Jn.* iii. p. 21, and the other works cited above.

APHANOCAP'SA, Nägeli.—A supposed genus of Unicellular Algæ. See Palmellaceæ.

APHANOCHÆ'TE, Braun.—A genus of Chætophoreæ (Confervoid Algæ) allied to *Coleochæte*; the bristles arising from the backs of the cells are not sheathed, but articulated in the upper part. Not yet detected in Britain.

Bibl. Alex. Braun, *Verjung.* p. 196, &c.; Ray Soc. Translation, *Rejuvenescence in Nature*, 1853, p. 184, &c.

APHANOTHECE, Nägeli.—A supposed genus of Unicellular Algæ. See Palmellaceæ.

APH'IDÆ.—A family of Insects belong-

ing to the order Hemiptera (Homoptera, Westwood). This family comprises the insects known as plant-lice.

Rostrum more or less perpendicular or inflexed, varying in length, being in some species longer than the body, and consisting of four joints (Pl. 44. fig. 1). Labrum long and pointed at the tip; antennæ of moderate or of great length, setaceous or filiform and composed of 5–7 joints, the last joint being sometimes obsolete and the third longest (Pl. 44. fig. 2). The ocelli, three in number, form a large triangle; the eyes are entire, prominent, and semiglobose. The thorax is oval, with the prothorax forming a transverse collar; the abdomen is short and convex, ovate or elongate-ovate, soft, and generally furnished with a more or less elongated tubercle on each side near the extremity. Wings, when present, four in number, the anterior much larger than the posterior, placed obliquely or nearly perpendicularly on the sides of the body in repose; the anterior with a strong subcostal nerve, terminating near the apex in a broad stigma, and giving off two or three oblique nerves running to the posterior margin of the wing; of these the one nearest the apex is usually forked once or twice. Legs usually very long and slender, with the thighs sometimes thickened; tarsi two-jointed. The body is sometimes clothed with a mealy or cottony secretion, secreted by roundish warts which stand in rows upon the back; in some species this covering is so long that the animal is entirely concealed by it, and looks merely like a moving flock of wool. It is sometimes employed by the females as a covering for their eggs.

The Aphidæ, like the rest of the order to which they belong, are active in all their stages; the pupæ being distinguishable from the perfect insects, only by their possessing the rudiments of wings upon the back of the thoracic segments. In the wingless species this distinction of course does not exist.

These insects reside, usually in large societies, upon almost every species of plant; but the different species of plant-lice, like the true lice of animals (Anoplura), are generally restricted to one or two particular plants; or when they are common to a greater number of vegetable species, the latter are usually very nearly allied. Each species is also restricted to some particular part of the plant; but no part is exempted from the attacks of particular species, which are found upon the young shoots, the buds, the leaves, the stem, even of trees, and the roots. Of these parts they suck out the juices, by placing the rostrum in a perpendicular position, and forcing the included bristles into the tissues of the plant; the wound thus formed is frequently enlarged by movements of the body of the animal. In some instances the irritation caused by these wounds, inflicted by a colony of Aphides, gives rise to a distorted state of leaves and twigs, and even to gall-like excrescences, in the interior of which the insects may be found in great numbers.

The abdominal tubercles or tubes above mentioned, which however are reduced to simple openings in some species, are generally regarded as excretory organs, through which a saccharine fluid is exuded. This fluid is produced by many Aphides, especially those which live upon trees and shrubs, in great abundance; it constitutes the well-known honey dew, which drops in large quantities from some of our common trees (particularly the Lime), and forms small shining spots upon their leaves. The latter were supposed by Liebig to be products of a disease of the plants upon which they occur. The sweet fluid is much liked by ants and other Hymenopterous insects, which seek the Aphides for the purpose of sucking it from them, sometimes inducing them to excrete it by stroking them with their antennæ, but sometimes biting and tearing them to get at it. Kaltenbach considers the abdominal tubes to be merely produced stigmata, and states that the saccharine fluid is emitted through the anus; this is also the opinion of De Geer, Kyber, and others.

The propagation of the Aphides presents some most remarkable peculiarities, and is well worthy of a careful study. The ordinary colonies of these insects, which may be met with everywhere during the summer, consist of winged and wingless individuals, the latter being for the most part larvæ and pupæ. The winged individuals are all viviparous and capable of producing young larvæ without any intercourse with a male insect. During the whole course of the summer, none but these so-called viviparous females are to be met with, and generation follows generation without the appearance of a single male. It is only in the autumn that males and true females are produced as the last result of the viviparous reproduction; these are usually apterous, even in the ordinarily

winged species; and, after copulating, the females lay eggs, which serve to continue the race in the following summer. The viviparous individuals of some species are, however, said to live through the winter; and the viviparous reproduction may be continued uninterruptedly for an indefinite period by the maintenance of the necessary conditions of temperature &c.; at least Kyber observed it for four consecutive years in a colony kept in a room at a uniform temperature.

The true nature of this wonderful mode of propagation has been the subject of much dispute, especially of late years. It will be unnecessary for us to enter upon the consideration of the various opinions that have been put forward; it is sufficient to mention that it is now generally admitted to be an example of the alternation of generations, which occurs so frequently amongst the lower animals,—the viviparous forms being regarded as the products of a sort of internal gemmation. According to Huxley, the organs in which the young of the viviparous forms are produced (*pseudovaria*), are strictly homologous with the true ovaries, and the germs of both forms are identical; but in the oviparous or true females, the germ is surrounded by a vitellus and vitelline membrane in the usual way to form a true egg; whilst in the viviparous individuals, the germinal vesicle itself enlarges and undergoes a considerable change before acquiring an investing membrane, within which the embryo is gradually developed in a very interesting manner.

From the nature of their reproduction, it will be easily understood that the fecundity of the Aphides must be very great. The most prolific species only live for about three weeks, and in that time produce 30–40, or according to Réaumur, 90–100 young. In these species there may be from 15–17 generations in the course of the summer; and Schrank, starting from Bonnet's observations, calculated the total theoretical progeny of a single Aphis in the course of one summer at 23,740,000. Their numbers are, however, constantly kept in check by the attacks of numerous enemies, amongst which we may mention the common Lady-birds, both in their larva and perfect states, the larvæ of the Dipterous genus *Syrphus*, and of the Hemerobiidæ which prey upon them; whilst many of the smaller Ichneumonidæ and Chalcididæ attack them for the purpose of depositing eggs in their bodies.

Notwithstanding these checks upon their production, the plant-lice increase sufficiently to render them exceedingly injurious to cultivated plants. The most noxious species are the turnip-fly (*Aphis Brassicæ*, Pl. 44. fig. 3), the bean-fly (*A. Papaveris*), which also occurs upon the poppy and various other plants, and the hop-fly (*A. Humuli*). The latter, when it abounds to an unusual extent, causes the almost total destruction of the crop of hops. One of the most abundant species is the rose-fly (*A. Rosæ*), which is often exceedingly injurious to roses in gardens, by attacking the young succulent shoots. *Lachnus Quercûs*, a large species with the rostrum three times the length of the body, is found in the fissures of the bark of old oaks; the other species of *Lachnus* live for the most part upon the shoots and leaves of coniferous trees; the commonest is the *L. pinicola*. *Eriosoma lanigera* (*Schizoneura*, Hartig) is a common species upon the stems of apple-trees, living in societies in crevices of the bark, on which it forms small, white, woolly patches. *Tetraneura Ulmi* (Pl. 44. fig. 4) lives in small gall-like excrescences on the leaves of the elm; and the *Pemphigus bursarius* (Pl. 44. fig. 5), a woolly species, resides in similar galls on the leaves and foot-stalks of the poplar. Of the subterranean species, which suck the roots of plants, the most abundant is *Trama radicis* (Pl. 44. fig. 6), which occurs upon various composite plants, including the common dandelion and the garden-lettuce. *Forda formicaria* (Pl. 44. fig. 7) is the species commonly found in ants' nests; it lives in small societies on the roots of grasses, and is tended with great care by the ants.

BIBL. Westwood, *Introduction, &c.*; Walckenaer, *Hist. d. Insectes*; Kaltenbach, *Monog. d. Pflanzenläuse*, 1843; Koch, *Aphiden*, 1857 (*figs.*); Burnett, *Silliman's Journal*, 1854, xvii. pp. 62, 261; Walker, *Ann. Nat. Hist.* 2nd ser. i. ii. iii. iv. &c. (1848–49 &c.); Claparède, *Ann. N. Hist.* xix. p. 360; Balbiani, *Ann. N. Hist.* 1866, xviii. pp. 62, 106; id. & Signoret, *Ann. N. Hist.* 1867, xx. pp. 20, 149; Boisduval, *Entom. Horticole*, p. 240; Huxley, *Linn. Trans.* xxii. pp. 193, 221.

APHRODI'TA, L. A genus of Annulata. One species of this genus (*A. aculeata*) is well known as the sea-mouse, and is commonly found on the sea-coast, and always admired on account of the splendid iridescent colours reflected from its spines

and bristly hairs. Its body is from 3 to 5 inches long, $1\frac{1}{2}$ broad, and oval; the back of an earthy colour. The head is small, entirely concealed, with two round clear spots, or eyes, on the vertex. The hairs and bristles run down each side of the body; the back is roughish, with a thick felt of hair and membrane forming a kind of skin. When this coat is cut through, fifteen nearly circular plates or scales (elytra) are found on each side, which partly cover each other, and the middle of which are the largest. If two of the plates lying next each other be separated, we then see upon the intermediate ring small tubercles divided by a pit, furnished behind with pectinate appendages, the gills or branchiæ.

Antennæ minute; palpi large, subulate, jointed at the base. Mouth with a large retractile edentulous proboscis; the orifice encircled with a short, even, thick-set fringe of compound penicillate filaments divided into two sets by a fissure on each side. Thirty-nine pairs of feet, biramous; the upper branch carries the long, flexible, brilliantly coloured bristles forming the silky fringe on each side of the body.

This animal is a very interesting object to the microscopist, as its tissues are very transparent and easily examined.

The brilliant colours of the bristles and hairs arise from iridescence, produced by a number of longitudinal striæ or interspaces between the component fibres of which the bristles and hairs consist; they also exhibit transverse splits or cracks; they are not materially changed by the action of boiling solution of potash, except that the external coat of the hairs becomes transversely wrinkled, giving these the appearance of being surrounded by a number of fibres (Pl. 40. fig. 20).

Bibl. Johnston, *Ann. Nat. Hist.* 1839, 430; Van. d. Hoeven, *Zool.* p. 232.

APHTHA.—A disease affecting the mucous membrane of the mouth, tongue, &c. It exhibits itself in the form of rounded patches of larger or smaller size, of a whitish or yellowish colour. One form of it, vulgarly called the "thrush," and in French *muguet*, which occurs very frequently in children, and in adults towards the fatal termination of chronic diseases, is of special interest to the microscopist, inasmuch as the patches consist of numerous epithelial scales mixed with filaments and isolated cells of a fungus. A portion examined under the microscope exhibits:—1, numerous oval cells (*a*, Pl. 30. fig. 1), rarely containing an internal globule or nucleus; 2, long filaments (*b*) exhibiting a further advanced stage of development; the filaments are but rarely jointed; 3, epithelial scales, sometimes perfect (*d*), but usually wrinkled and otherwise altered in form, and frequently more or less opaque (*e*), so as to be hardly recognizable except when treated with potash; intermingled with these bodies are sometimes vibriones or bacteria (*Bact. termo*, *f*) and a molecular form of matter (*g*), probably an early stage of *Bact. termo*; for it is always found with and prior to it in decomposing liquids, in addition to the molecular granules found in all animal liquids.

This fungus appears to arise in the same manner as other analogous fungi, as those in kept organic liquids, in urine, &c.; the spores are probably always floating in the air and dropping from it upon all the exposed parts of the body; and wherever they find a proper nidus, there they grow. In diseases accompanying or preceding aphtha, the regeneration of the oral epithelium is probably to a great extent checked, the secretion of the saliva also, which would wash away these organisms; why they occur so frequently in infants, is probably owing to the saccharine nature of the diet, which is especially favourable to their development.

It is to be observed of the numerous parasitic Fungi which have been described as preying on animal tissues, that a great portion are mere conditions of common species of *Aspergillus*, *Penicillium*, *Mucor*, &c., which assume different forms according to the nature of the matrix. This has not been sufficiently kept in view by authors unacquainted with the genera of Fungi; and in consequence, a great number of spurious genera have been proposed, and considerable confusion has ensued; while the fashion of late with Dr. Hallier and his followers has been to confound things which are essentially distinct. See Oidium.

Bibl. C. Robin, *Hist. Nat. d. Végétaux Parasites*, 2nd ed., Paris, 1853, p. 488, where many other works are mentioned.

APIOCYSTIS, Nägeli.—A genus of Palmellaceæ (Confervoid Algæ). Aquatic plants parasitical upon Confervæ, consisting of pear-shaped or clavate vesicles from 1-50′ to 1-20″ high, and about half as thick, attached by the narrow extremity, and containing numerous green primordial cells about 1-2500 to 1-3500″ in diameter. Young sacs contain regularly 2, 4, 8, 16, 32, &c.;

and in large ones the number amounts to 300 to 1600. At first they lie irregularly in the cavity, afterwards they lie upon the wall in one or more layers; sometimes they are attached to the wall in groups of eight. At a certain stage, the primordial cells become again free in the cavity, move actively, and finally escape by the rupture of the sac, swarm as biciliated zoospores for a time, then settle down and germinate.

A. Brauniana (Pl. 45. fig. 5) and the doubtful species *A. linearis* represent this genus. The former has been detected in Britain.

Bibl. Nägeli, *Einzelligen Algen*, p. 67, t. 2. A. figs. 1 and 2; Henfrey, *Trans. Mic. Soc.* New Series, iv. p. 49. pl. 4.

A'PIS, L.—A genus of Hymenopterous insects.

A. mellif'ica, the honey-bee, presents some interesting points of structure.

The proboscis (Pl. 26. fig. 25) agrees essentially with that of *Anthophora*. The "tongue" (labium *) is a very beautiful and favourite microscopic object; its minute structure requires a higher power than that used in making our sketch, to render distinct the elegant transverse ridges or folds and the terminal hairy lobe.

The legs are peculiarly formed for the special purpose of collecting and carrying the pollen of flowers. The tibiæ of the hind legs are dilated, smooth on the outside in the neuter or working bees, and hollowed into a shining plate (Pl. 27. fig. 4 *b*), whilst the basal joint of the tarsi is hooked at its outer superior angle and dilated into an oblong or somewhat triangular plate (Pl. 27. fig. 4 *a*), which is furnished with transverse rows of hairs, forming pollen-brushes.

Bibl. Westwood, *Introduction*, &c.; Curtis, *Brit. Entom.* 769.

APLANATISM.—Freedom from spherical aberration (in lenses). See Optics.

APLIDIUM, Sav.—A genus of Mollusca, of the order Tunicata, and family Botryllidæ.

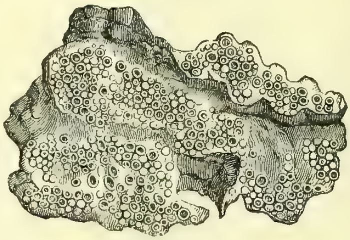
The common mass is from 1–3 inches high; and the animal bodies about $\frac{1}{6}$–$\frac{1}{2}''$ inch long. Four British species:—

A. ficus, dark olive, orifices six-rayed; *A. fallax*, honey-yellow, with white and brown specks, orifices circular; *A. nutans*, straw-yellow, tinted with brown, orifices invisible; and *A. verrucosum*, olive-green, orifices entire.

Bibl. Forbes and Hanley, *Brit. Mollusca*, i. 10.

APOTHECIUM.—The name applied to the spore-fruits of the Lichens, sometimes restricted to those of the open-fruited genera

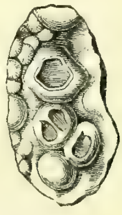
Fig. 26.



Dirina Ceratoniæ.

(Gymnocarpi), the term *perithecium* being applied to those of the closed-fruited (Angiocarpi). Several special names have been applied to the apothecia, namely, *pelta*, *scutella*, *patella*, *scyphus*, *orbiculus*, *lirella*, and *verruca*, indicating the forms occurring

Fig. 27. Fig. 28.



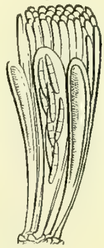


Fig. 27. Apothecia, magnified. Fig. 28. Thecæ and paraphyses, from a vertical section of an apothecium, magnified 200 diameters.

in particular genera. They are shield-shaped, flat, cup-shaped, globular, papilliform bodies or linear ridges, upon the upper surface of the thallus, either immersed, superficial or elevated on peduncles. They contain the thecæ or spore-cases. For the structure, see Lichens.

APPENDICULARIA, Cham.—A genus of Mollusca, of the order Tunicata, and family Salpidæ.

1 British species: *A. flagellina.*

Bibl. Gosse, *Mar. Zool.* i. p. 37; Chamisso, *Nova Acta Acad. Cur.* x.; Huxley, *Phil. Trans.* 1851, p. 595.

APTOG'ONUM, Ralfs.—A genus of Desmidiaceæ.

Char. Filament elongated, triangular or flattened; joints bicrenate at the free margins; an oval foramen between the joints.

Kützing and others place this organism in the genus *Desmidium*, where it might very well have remained.

1. *A. Desmidium.* Joints in front view quadrangular, broader than long.

α. Filaments triangular, regularly twisted, crenatures rounded; length of joints 1-1500″, breadth 1-1000″ (Pl. 10. fig. 55, front view; fig. 52, side view).

β. Filaments flattened; crenatures shallower and slightly angular.

2. *A. Baileyi.* Filaments not crenate; joints about equal in length and breadth. American.

The latter cannot be retained in this genus, unless the characters be altered, on account of the absence of the crenatures.

Bibl. Ralfs, *Brit. Desmid.* pp. 63, 208.

A'PUS, Scop.—A genus of Entomostraca, of the order Phyllopoda, and family Aspidephora.

Char. Head, body, and greater part of the abdomen covered by a shield-like carapace, which is deeply notched behind; eyes two, sessile and approximate; a single pair of minute, short, styliform and two-jointed antennæ; legs, sixty pairs, the first pair furnished with three long jointed branches, extending beyond the carapace, the rest branchial; body composed of numerous rings; two long jointed caudal appendages.

1. *A. cancriformis.* Aquatic, in stagnant pools; brownish yellow; length $2\frac{1}{2}$ inches.

2. *A. productus.* Not British; an elongated oval lamina between the two caudal appendages.

Bibl. Baird, *Brit. Entom.* p. 18.

AQUATIC.—This term is used throughout this work to signify an inhabitant of fresh water, as opposed to *marine*, inhabiting the sea.

ARACHNI'DA.—A class of animals containing the spiders, scorpions, &c.

Char. Head united with the thorax, forming a cephalothorax; antennæ none; eyes simple (ocelli); legs eight, jointed.

The integument of the Arachnida is usually soft and leathery, rarely horny or brittle, and consists principally of chitine. Two layers may usually be distinguished, an outermost or cuticle, which is the firmest and strongest, and not unfrequently exhibits a cellular appearance in the extremities and the cephalothorax. The cuticle of the abdomen of the Araneæ, Acarina, &c. presents very beautiful wavy or undulating lines, sometimes surrounding the roots of the hairs &c. concentrically, and arising, in some cases at least, from the existence of folds (Pl. 2. figs. 4 & 5). The cuticle of the Arachnida is frequently covered with warty and bulbous excrescences, bristles and simple or feathery hairs, and sometimes with scales.

The innermost cutaneous layer consists of a very delicate and almost colourless membrane, of a finely granular or fibrous appearance, close beneath which is situated a layer of pigment granules and cells, which are visible through the general integument, and to which the beautiful colours of many of the Arachnida are owing.

The organs surrounding the mouth vary in structure in the different families. In the Spiders, two mandibles are situated at the front of the head. These consist of two joints,—a basal, very thick one (Pl. 2. fig. 6 *a* & 7 *a*), and a terminal, curved and sharply pointed one (fig. 6 *b* & 7 *b*). The latter is traversed by a canal terminating at its apex, through which the secretion of a poison-gland passes into any body transfixed by the claw. These mandibles are perhaps, strictly, modified antennæ. Next come two maxillary palpi (fig. 7 *c*), which do not differ in structure from the legs, except in their tarsi being composed of a single joint, generally terminated in the females by a small hook, but in the males of more complicated structure: the basal joints of these palpi are enlarged and project forward, forming the maxillæ (fig. 7 *d*); in the scorpions, the mandibles and maxillary palpi terminate in pincers or forceps; lastly a labium, situated between the maxillæ (fig. 7 *e*), and consisting of a single piece.

The mouth in the other families is described under the respective heads.

The eyes are simple (ocelli, stemmata), but they are absent in the parasitic Acarina; they consist of a simple arched cornea, a spherical lens and a concavo-convex vitreous body, with a cup-shaped retina, and a layer of pigment corresponding to the choroid.

The cephalothorax is usually separated from the abdomen by a well-marked constriction; but sometimes the head, thorax, and abdomen are fused together.

The legs of the Arachnida, which are attached to the cephalothorax, do not coincide exactly with those of insects. They usually consist of seven segments tapering towards the end, so that the tarsi are less distinct from the other parts than in insects. If we suppose that the last two joints belong to the tarsus, the tibia then consists of two joints, of which, in some (the scorpion and

Phrynus) the first, in others the second is the longest. The preceding long joint is the femur, to which comes next an annular or inverted conical joint, corresponding to the trochanter of the six-footed insects. The first, broad, usually inversely conical joint, which is adherent to the cephalothorax, corresponds to the coxa of insects. The last joint of the tarsus usually supports three curved hooks or claws (Pl. 2. fig. 8), which are frequently toothed on the concave margin, and in some a membranous vesicular or hairy cushion (pulvillus) on its under side. The most characteristic feature of the Arachnida consists in the division of the tibia into two unequal pieces.

The *alimentary canal* is mostly short and straight. In the Araneæ the œsophagus enlarges into a prismatic muscular expansion just before its termination in the stomach; the stomach splits just behind the above apparatus into two branches which curve forwards and form a ring, from which five pairs of diverticula pass to the roots of the legs and palpi.

Salivary glands are present, consisting in the Araneæ of a transparent glandular mass situated in a cavity above the palate; also a hepatic apparatus, in the form of a compact mass, consisting of a number of ramified and closely-crowded cæca, containing the hepatic cells and opening at about the middle of the alimentary canal in four short ducts. This hepatic apparatus was formerly mistaken for the fat-body. In the Tardigrada, Acarina, and some others the liver is represented by the granule-cells, usually brownish yellow, of the walls of the diverticula of the stomach.

The poison-glands of the Araneæ consist of two long, sometimes slightly curved blind sacs, the walls of which are surrounded by a simple spiral layer of muscular fibres.

Circulatory System.—In the lower Arachnida, as the Tardigrada, Acarina, &c., there is neither dorsal vessel nor blood-vessels. Hence in these there is no regular circulation of blood; but the nutritive fluid or the blood is distributed free in the interstices of the body, and is irregularly moved backwards and forwards, propelled in the cavity of the body, and into the extremities, by muscular movements and the contractions of the intestinal canal.

In the Araneæ there is a dorsal vessel, consisting of a spindle-shaped tube lying principally in the abdomen, constricted at intervals and furnished with lateral apertures and valves. This heart sends off lateral and terminal arterial branches, which gradually become lost. There are no veins; but the further course of the blood takes the form of lacunal currents, which re-enter the heart at the valvular orifices.

In the scorpions, there are veins as well as arteries.

Respiratory System.—In the Tardigrada and some parasitic Arachnida, *Demodex, Sarcoptes, Acarus,* &c., no tracheæ or other respiratory organs have yet been discovered; hence the respiration must be cutaneous. The higher Arachnida breathe either by tracheæ (many Acarina), or by lungs, or by both.

The tracheæ of the Acarina are remarkably delicate, so that the spiral fibre is with great difficulty distinguishable. They arise usually in an unramified bundle from two stigmata, which are sometimes situated anteriorly between the front legs, as in the Hydrachnea, and much concealed, at others, at the sides of the body above the third pair of feet, as in the Gamaseæ, or behind the last pair, as in the Ixodeæ. They are usually more tufted than branched as in insects.

In the Hydrachnea, which live in the water, and do not rise to the surface to respire, the tracheæ must possess the power of absorbing the air from the water. In the Araneæ, the lungs consist of rounded sacs situated at the anterior part of the under surface of the abdomen, and open externally by a transverse slit. At the outer convex surface of each lung-sac there are a number of thin but firm triangular or rhomboidal plates, like the leaves of a book, closed together (Pl. 2. fig. 9). When examined by reflected light, they present a silvery lustre; whilst by transmitted light they appear dark violet, or almost black. Each of these plates consists of a fold of the skin, between which the air of the sac is widely distributed: they contain no blood-vessels, hence probably the blood brought by the arteries is poured out around the lungs, and so bathes the lung-plates. The position of the lung-sacs is indicated externally by a triangular and horny cutaneous plate, at the posterior margin of which the respiratory fissure exists. Behind these fissures there are two other openings, the orifices of a tracheary system which does not differ materially from that of such as have tracheæ only.

Nervous System. — Varies in degree of complexity. In its simplest form it exists as a single œsophageal ganglion, sending off radiating branches; and in its most compound forms it presents a large cephalo-thoracic

bilobed ganglion, and one or two ventral ganglial chains or cords.

The primitive nervous fibres and ganglion-cells are very small and delicate.

Spinning organs.—These organs, by means of which the Araneidæ form their webs, are of great interest. The external organs consist of three or rarely two pairs of cones or conical papillæ, or spinnerets, placed at the end of the abdomen, below the anus: they are somewhat flattened at the summit; and usually the middle pair consist of two joints, and the anterior and posterior pairs of three joints. The sides of the cones are covered with hairs, and on the summits are a number of delicate horny spinning-tubes, at first sight closely resembling hairs; these form continuations of the spinning vessels. Sometimes, however, the lower portions of the sides of the cones are furnished with spinning-tubes, the remainder being covered with hairs. Each spinning-tube consists of two parts:—a thicker basal portion, and a thin terminal portion, from the orifice of which the substance of the fibre exudes (Pl. 2. fig. 10, 10 *a*, separate tubes). The number of these spinning-tubes varies according to the species, the sex, and the age of the spiders. In some there are more than 1000, in others 400, 300, 100, &c., and in others still fewer. The glands which secrete the tenacious transparent secretion are very variable in number, form, and arrangement, and occupy the interstices of the other abdominal viscera, consist of sacs and tubes, lined with nucleated cells, and either simple or variously ramified, terminating in ducts which open at the roots of the spinning-tubes.

The filaments of which the webs of many spiders are composed are not all alike. The radiating filaments are but little elastic, and are composed simply of one or more threads; whilst the more numerous (tangential) filaments connecting these are covered at tolerably regular intervals with minute spherical masses of glutinous matter (Pl. 2. fig. 11), the filaments themselves being highly elastic. These masses give the fibres an elegant beaded appearance under low powers of the microscope. The viscid masses cause the more ready adhesion of the filaments to insects which may accidentally become entangled in them, and render the spider more sure of holding his prey.

Propagation.—The Arachnida generally are propagated by sexes. The sexual apparatus consists of two ovarian or seminal sacs, sometimes fused together in the middle line; they are situated in the abdomen, and terminate in two excretory ducts, which usually open at a common orifice placed at the base of the abdomen, or below the cephalothorax. A penis is not generally present; the seminal fluid is applied to the vulva of the female by the maxillary palpi of the male.

Spiders are oviparous, and the eggs are enveloped in a cocoon. They are often elegantly sculptured.

The Arachnida may be thus subdivided:

Order 1. ARANEIDA. Cephalothorax constricted from the unjointed abdomen; palpi unarmed.

Order 2. PEDIPALPI (Phrynida). Cephalothorax distinct from the jointed abdomen; palpi large, leg-like, chelate at the end. (Pulmonary sacs present.)

Order 3. SOLIFUGÆ (Solpugida). Cephalothorax distinct from the jointed abdomen; palpi filiform, extended, as long as the legs, unarmed.

Order 4. PSEUDOSCORPIONES (Obisida); Book-scorpions. Cephalothorax distinct from the ringed abdomen; palpi large, chelate. (Tracheæ only present.)

Order 5. PHALANGITA (Opilionina); Harvest-spiders. Cephalothorax distinct from the annulate or transversely plicate abdomen; palpi simple, filiform; mandibles chelate; legs very long, terminated by a single claw.

Order 6. ACARINA (Mites). Head, thorax, and abdomen fused together; legs distinctly jointed; palpi simple.

Fam. 1. Acarea. Head terminated in front by an emarginate labium, or single bifid process; palpi adnate or adherent to the labium, difficultly distinguished; mandibles chelate; no distinct ocelli; legs generally terminated by a vesicle or adhesive acetabulum and claws.

Fam. 2. Oribatea (Notaspidea). Body covered by a hard horny envelope; mandibles chelate; palpi fusiform, 5-jointed; legs furnished with claws, but no vesicle or acetabulum.

Most of the species live in mosses at the roots of trees; in some the body is surrounded by a projecting lamella on each side.

Fam. 3. Ixodea. Palpi canaliculate, sheathing the rostrum; mandibles three-jointed, basal joint internal, second joint external and long, third short and denticulate; labium covered with reflexed teeth. (Parasitic.)

Fam. 4. Gamasea. Palpi free, filiform;

mandibles chelate; feet with two claws and a caruncle, or a lobed membranous appendage; ocelli none or indistinct. (Generally parasitic.)

Fam. 5. Hydrachnea. Palpi with the last joint unguiculate or spinous; two or four distinct ocelli; coxæ broad, legs generally ciliated, natatory, the posterior longest. (Aquatic.)

Fam. 6. Bdellea. Palpi antenniform; mandibles terminating in claws or pincers; rostrum resembling an elongated head; body generally divided between the second and third pairs of legs by a transverse furrow or stricture.

The species consist of minute animals, more or less soft, variously coloured, and living in damp places beneath moss, upon sand of caves, &c.

Fam. 7. Trombidina. Palpi with the last joint obtuse, the second joint very large; the last but one (penultimate) resembling an incurvated claw; feet cursorial, terminated by two claws.

Order 7. TARDIGRADA (Colopoda); Water-bears. Legs rudimentary, very short, conical, indistinctly three-jointed, and with three or four claws; abdomen not distinct from the thorax. (Aquatic.)

Gen. *Emydium, Macrobiotus, Milnesium.* (*Tardigrada.*)

Order 8. PYCNOGONIDA (Polygonopoda); Crab-spiders. Cephalothorax forming a 4-jointed body; abdomen rudimentary (small and conical); legs as long as or longer than the body.

Genera. — *Pycnogonum, Phoxichilus, Phoxichilidium, Pallene, Pariboea, Nymphon, Endeis, Ammothea.*

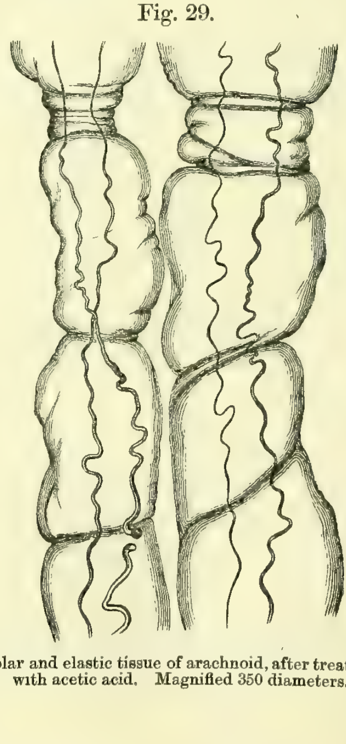
Sluggish marine animals, living under stones, upon marine plants, or parasitic upon fish and crustacea.

BIBL. Treviranus, *Ueb. den inner. Bau der Arachniden*; id. *Vermischte Schriften, &c.* Bd. 1, 1816; Dufour, *Ann. d. Sc. physiq. de Bruxelles,* iv.–vi.; Walckenaer, *Hist. nat. d. Ins. Apt.* i.–iii.; Van der Hoeven, *Handb. der Zoologie,* i.; Siebold & Stannius, *Lehrb. d. vergl. Anat.* i.; Owen, *Hunter. Lectures,* i.; Blackwall, *Brit. Spiders* (*Ray Soc.*), and *Linn. Trans.* xvi.; Blanchard, *Ann. N. H.* 1850, vi. 67; and 1852, x. 150; Newport, *Phil. Trans.* 1843; Koch, *Die Arachnid.* (534 pls.); Claparède, *Rech. s. l'évolut. &c.* 1863; id. *Etudes s. l. Circulation, &c., Ann. N. Hist.* 1865, xv. p. 16; Jones, *Anim. Kingd.* 1870; Gegenbaur, *Vergl. Anat.* 1870; Walker, *Brit. Spiders* (*Ray Soc.*).

ARACHNOID MEMBRANE (*Tunica arachnoidea*).—Is a delicate transparent membrane, lying between the cranial dura mater and the brain, and extending between the spinal cord and its dura mater so as to envelope these nervous centres. It does not dip between the convolutions of the brain, but enters and lines its ventricles. Its outer surface is covered by a delicate epithelial layer; its inner surface is smooth, but not covered with epithelium. It is reflected upon the surface of the dura mater as an epithelial layer only. It consists principally of reticulated bundles of areolar (cellular) tissue, with fibres of elastic tissue coiling around or pursuing a rectilinear course through them. In some parts the fibrillæ of the former run parallel without forming bundles, and contain, as do the bundles, round, elongated, or spindle-shaped nuclei. In others, areolar tissue of a rather homogeneous appearance here and there forms a coat to the bundles, or is situated between them.

Fig. 29 represents two bundles of the areolar tissue of the human arachnoid, after the addition of acetic acid, showing the fibres of elastic tissue.

Fig. 29.



Areolar and elastic tissue of arachnoid, after treatment with acetic acid. Magnified 350 diameters.

BIBL. Kölliker, *Mikrosk. Anat.* ii.; Henle, *Allgem. Anat.*

ARACHNOIDISCUS, Bailey (Hemiptychus, Ehr.).—A genus of Diatomaceæ.

Char. Frustules adherent, disk-shaped; valves plane or slightly convex, with radiating and concentric lines (rows of dots), and a central pseudo-nodule.

The markings upon the inner valves are not the same as those upon the outer (or parent); hence the mere variations of the markings are not characteristic; nor is the number of rays constant.

A. ornatus, Ehr. Valves very finely granular; rays 29, equal. In Patagonian guano.

A. Ehrenbergii, Bail. Pseudo-nodule surrounded by an inner ring of linear radiating and an outer ring of circular or angular markings (depressions); marine; breadth 1-200 to 1-60″; occurs also in guano. (Pl. 12. figs. 12 & 13, side view.)

A. indicus (Pl. 42. fig. 3).
A. nicobaricus (Pl. 42. fig. 4).
} Fossil in Nicobar Islands.

BIBL. Ehr. *Ber. d. Berl. Akad.* 1848 & 1849; Smith, *Brit. Diat.* i. p. 25; Shadbolt, *Trans. Micr. Soc.* iii.; Arnott, *Micr. Journ.* 1858, 159; Greville, *Micr. Trans.* 1865, p. 47.

ARANE'IDA.—A family of Arachnida, comprising the true spiders.

The species of genera belonging to this family (as *A. civilis* and *domestica*, house-spiders, *Epeira diadema*, garden-spiders &c.) are readily accessible for examining the structural peculiarities of spiders—the skin, the eyes, the organs of the mouth, the maxillary palpi, the spinnerets, the legs, &c. (See Pl. 2.)

BIBL. Walcken. *Aptères*, i.; Koch, *Die Arachn.* viii.; Treviranus, *Ueb. d. inn. Bau d. Arachn.*; Walker, *Brit. Spiders.*

ARAUCA'RIA, Jussieu.—A genus of Coniferæ (Gymnospermous Flowering Plants), remarkable for the character of the markings on the walls of the cells of the wood, where the pits or bordered pores appear in two or more parallel rows (Pl. 39. fig. 5). *Araucaria* (*Eutassa*) *excelsa* is the Norfolk-Island Pine, which grows to an immense size, as do also *A. brasiliensis*, *A. imbricata*, &c. The reservoirs of turpentine seem to be in the bark and not in the wood. See CONIFERÆ, WOOD, and SECONDARY LAYERS.

ARAUCARITES, Goeppert (*Dadoxylon*, Endlicher; *Pinites*, Lindl. and Hutt.).—A genus of Fossil Coniferæ, characterized by a structure resembling that of Araucaria.

BIBL. Witham, *Intern. Struct. of Fossil Vegetables*, p. 72, pl. 4-11. Edinb. 1833; Lindley and Hutton, *Fossil Flora*, l. t. 2, 3.

ARCEL'LA, Ehr.—A genus of Rhizopoda, of the family Arcellina.

The Arcellæ correspond to Amœbæ contained in a carapace. In some species the carapace is membranous and uniform; in others it is calcareous and exhibits fine striæ, depressions, or granules spirally arranged.

The species (?) are numerous; the most common are:—

1. *A. vulgaris* (Pl. 23. fig. 14*a*). Carapace brownish yellow, plano-convex, or hemispherical, covered with depressions. These markings or depressions are very beautiful and interesting. They agree exactly with those upon the valves of the Diatomaceæ in regard to the requirements for their display; with unilateral oblique light, lines only are visible. Their true structure resembles that in Pl. 11. fig. 41, or Pl. 13. fig. 29, except that the rows are somewhat wavy or even spiral. Aquatic; breadth 1-500 to 1-200″. In the young state it is very transparent and pale, and the markings are with difficulty distinguished. The shell is cast several times before arriving at maturity. Pl. 25. fig. 24 represents the animal with its processes protruding from the carapace.

We have seen two of these animals conjugating and so firmly united by the soft internal substance, that they were not separable by rolling them over between two plates of glass.

2. *A.* (*Echinopyxis*) *aculeata* (Pl. 23. fig. 14 *b*). Carapace brownish, discoidal, convex above, with one or more irregular spinous prolongations at the margin; aquatic; breadth 1-200″ without the spines.

3. *A. dentata* (Pl. 23. fig. 14 *c*). Hemispherical, anguloso-polygonal; carapace membranous, homogeneous, yellowish or greenish; aquatic; breadth 1-560 to 1-200″.

4. *A. aureola* (*Cyphidium aureolum*, Ehr.) (Pl. 23. f. 38). Carapace yellow, angular, with numerous tubercles, four of which are larger and more projecting; a single expansion of varied size; breadth 1-560 to 1-420″; aquatic. Fig. 38 *a* represents the carapace viewed from above, *b* the same supported upon one angle, and the single expansion.

BIBL. Ehrenberg, *Infusionsth.*; Dujardin, *Infusoires*; Claparède and Lachmann, *Infus.* p. 444.

ARCELLI'NA, Ehr.—A family of Lobose Rhizopoda.

Char. Animals contained in a univalve membranous or solid inflexible carapace,

of an urceolate or shield-like form, with a single orifice from which one or more irregular and variable expansions are protruded, which form the organs of locomotion.

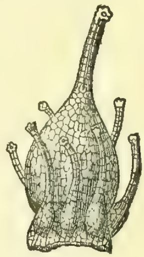
The substance of the body resembles that of an *Amœba.* Gen.:—

Shell flexible .... *Pseudochlamys.*
Shell solid, inflexible.
Not incrusted with foreign matters. *Arcella.*
Incrusted with agglutinated foreign matters.
With tubular prolongations ... *Echinopyxis.*
Without tubular prolongations *Difflugia.*

ARCHEGO'NIUM. Also called *pistillidium.*—The rudimentary organ representing the ovule in the higher Flowerless Plants, such as Mosses, Ferns, &c. (excluding the Thallophytes). These organs are more minutely described under the heads of the various Classes, in speaking of their reproduction.

In the Mosses and Liverworts they are flask-like cellular bodies, found in terminal or axillary buds on the leafy stems (figs. 30 & 31). In the Ferns and Equiseta they are

Fig. 30. Fig. 31.

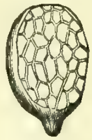


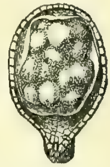
Archegonia of Mosses.
Magnified 50 diameters.

produced on the prothallium, after the germination of the spores. In the Lycopodiaceæ and Marsileaceæ they are produced upon the cellular plate, representing a prothallium, developed in the large spores when these begin to germinate. The *corpuscula* of the Coniferæ are analogous bodies to the last. See HEPATICACEÆ, MUSCACEÆ, FILICACEÆ, EQUISETACEÆ, LYCOPODIACEÆ, MARSILEACEÆ; also CONIFERÆ and CHARACEÆ.

ARCHID'IUM, Bridel.—A genus of Phascaceæ (Acrocarpous Mosses), of which but one species is found in Europe (*A. phascoides* = *Phascum alternifolium*, Hook. and T.), growing upon banks and fallow ground, on clay or chalky soil. It is remarkable for the sessile globular capsule, without a trace of an operculum, the columella soon obliterated, and the spores being few in number, very large and angular in form (figs. 32 &

Fig. 32. Fig. 33.





Archidium.
Open capsules, devoid of columella and with large spores. Magnified 40 diameters.

33). The calyptra is torn away in the middle during the expansion of the capsule, as in *Sphagnum*, leaving a short tumid vaginula.

BIBL. Wilson, *Bryolog. Britannica*, p. 24.

ARCTO'A, Br. and Sch. = DICRANUM.

ARCYR'IA, Hill.—A genus of Myxogastres (Gasteromycetous Fungi), growing on rotton wood, with frequently bright-coloured spores and filaments. The elastic filaments of the capillitium have no spiral fibres, but are a little tuberculated. The species in general are not confined to Europe or the United States, but have a very wide geographical range, occurring in tropical and subtropical districts as well as in those which are temperate. Species:—

1. *A. punicea*, Pers. Common; spores and capillitium purplish vermilion. Grev. *Sc. Crypt. Flora*, t. 130.

2. *A. incarnata*, Pers. Not uncommon; smaller, with a shorter stipes and with flesh-coloured spores and capillitium.

3. *A. cinerea*, Bull. Spores and capillitium cinereous.

4. *A. nutans*, Bull. Spores and capillitium dirty-yellow; capillitium nodding. *Trichia nutans*, Sowerby, t. 260; *Arcyria flava*, Grev. *Sc. Crypt. Fl.* t. 309.

5. *A. umbrina*, Schum. Spores and capillitium ochraceous, capillitium erect; peridium ovate.

6. *A. ochroleuca*, Fr. Spores and capillitium pale-ochraceous, peridium globose, evanescent; smaller than the preceding; 1-12″ high.

BIBL. Berk. *Hooker's Brit. Flora*, ii. pt. 2. p. 318; *Crypt. Botany*, p. 337; Fries, *Summa Veget.* p. 456.

ARE'CA, L.—A genus of flowering plants (Fam. Palmaceæ). The albumen of the seed of the *Areca catechu* (the Areca nut as it is called) affords a good instance of horny consistence produced by secondary layers upon

the cell-walls (Pl. 38. figs. 21 & 22). See ALBUMEN (of seeds).

AREG'MA, Fries.—A genus of Coniomycetous Fungi closely allied to *Puccinia*, comprising the species with many cells which occur on various *Rosaceæ*, as the common dark Parasite of the Rose and Bramble. Like *Puccinia*, the species always seem connected with a Uredinous form, and are propagated by secondary spores produced on the multiseptate bodies after germinating.

BIBL. Fries, *Summa Veg.* p. 507; Berk. *Crypt. Bot.* p. 325; Tulasne, *Ann. d. Sc. Nat.* 1847, Jan. p. 12; De Bary, *Untersuch. üb. d. Brandpilze.*

ARE'OLAR TISSUE of animals. See CELLULAR TISSUE.

AR'GAS, Walck.—A genus of Arachnida, of the order Acarina and family Gamasea.

Char. Rostrum inferior, concealed, as also the palpi, beneath a projection of the anterior part of the body; under part of body granular, not scaly, and consisting of a single piece; first joint of the palpi longest; legs approximate at their insertion, feet terminated by two claws, but no vesicle.

These animals are frequently parasitic upon pigeons, fowls, &c.; some live in gardens.

A. reflexus (*Rhynchoprion Columbæ*, Herm.). Body marked with tortuous furrows and depressions, yellowish or violet after food. On pigeons, especially when young.

A. persicus. Blood-red colour, back covered with scattered elevated white spots. The venomous bug of Persia; said to cause death in the human subject.

There are other species.

BIBL. Gervais, *Walcken. Aptères*, iii.

AR'GULUS, Müll.—A genus of Crustacea, of the order Siphonostoma and family Argulidæ.

Char. Carapace membranous, covering the cephalothorax like a shield; antennæ four, short, concealed beneath the carapace, anterior two-jointed, terminal joint hooked; posterior four-jointed; rostrum acuminate; five pairs of legs, the place of the first (6th) pair being occupied by two suckers; second pair short, five-jointed, the two basal joints spinous, the last joint with two small hooks; the last four pairs of legs two-cleft, and furnished with ciliated filiform processes.

A. foliaceus (Pl. 15. fig. 1). Parasitic on the stickle-back (*Gasterosteus*) and other fishes; carapace greenish.

BIBL. V. d. Hoeven, *Handb. d. Zool.*; Baird, *Brit. Entomostraca*, p. 242; Thorell, *Ann. Nat. Hist.* 1866, xviii. p. 149.

ARPAC'TICUS, Baird.—A genus of Entomostraca, of the order Copepoda and family Cyclopidæ.

Char. Head undistinguishable from thorax; foot-jaws two pairs, forming strong cheliform hands; antennæ in male furnished with a swollen hinge-like joint; antennules (inferior antennæ) simple; legs five pairs, the fifth pair rudimentary; eye single; ovary single. Two species:—

A. chelifer and *A. nobilis.* Marine, closely resembling *Cyclops.*

BIBL. Baird, *Brit. Entom.* p. 212.

ARRENU'RUS, Dugès.—A genus of Arachnida, of the order Acarina and family Hydrachnea (= Caudate Hydrachnæ).

The posterior part of the body of the male is narrowed and produced into a truncate or cylindrical appendage. The body of the female is truncated posteriorly. The prolongation is terminated by two angles and a sinuous intervening margin. At the middle of the latter is situated the penis; above which are two hooks. In both sexes the back is hard, crustaceous, as if shagreened, or spinous. In some species the thicker layer of the skin is furnished with a number of conical apertures (Pl. 2. fig. 12). The eyes are two, distinct, blackish. The intestinal cæca are distinguishable through the skin. The mouth is round and surrounded by a kind of hood (Pl. 2. fig. 13 *c*).

Arrenurus viridis, Dugès's typical species (Pl. 2. fig. 13), has the palpi short and clavate (*a*); the fourth joint longest and largest, the fifth falcate and the mandibles unguiculate (*b*).

The species are very numerous and of almost all colours, red, green, yellow, grey, purple.

BIBL. Walcken. *Aptères*, iii.; Dugès, *Ann. d. Sc. Nat.* 2 sér. i.; Koch, *Uebersicht d. Arachnidensystems.*

ARROW-ROOT.—A name given to various kinds of starch, derived from the plant *Maranta arundinacea*, and other species. True West India arrow-root is from this (Pl. 37. fig. 26) and *M. Allonga* and *M. nobilis* (N. O. Marantaceæ). East-India arrow-root is obtained from species of *Curcuma* (N. O. Zingiberaceæ) (Pl. 37. fig. 19), and apparently also from a *Sagus*, if we may judge from a specimen (Pl. 37. fig. 18) from Singapore. Tahitan arrow-root (Pl. 37. fig. 22) is obtained from the plant called *Tacca pinnatifida* (N. O. Taccaceæ); and the substance called Portland arrow-root (Pl. 37. fig. 11)

is extracted from the *Arum maculatum* (N. O. Araceæ), a common hedge-weed in this country. In all these cases the fecula consists of starch-grains, which are produced in great quantity before the season of rest, in the succulent tubers or rhizomes of the plants; the arrow-root is extracted from the grated root-stocks by washing, to separate the cellular tissue and remove the often acrid juices. See STARCH.

The arrow-root of the shops is subject to adulteration with cheaper kinds of starch, especially with sago and potato-starch.

BIBL. Pereira, *Mat. Med.*; Hassall, *Food and its Adulterations*, p. 31.

ARSENIC.—The common term for arsenious acid. Arsenious acid assumes two crystalline forms, and occurs also in an amorphous state.

The most common form is the octahedral or tetrahedral. The second (right rhombic) is less common, and is only obtained by sublimation. Attention to the form of the crystals is important, because it is used as a means of identifying arsenic in cases of poisoning. It must, however, be borne in mind that protoxide of antimony ($Sb\ O_3$) yields crystals by sublimation of exactly the same form as those of arsenious acid (Pl. 6. fig. 22).

Solution of arsenious acid is sometimes used as a preservative liquid for animal preparations.

BIBL. See CHEMISTRY; Guy, *Microsc. Trans.* 1861, p. 54.

ARTE'MIA, Leach.—A genus of Entomostraca, of the order Phyllopoda and family Branchiopoda.

Char. Abdomen prolonged in the form of a tail, composed of nine segments or joints, the end joint simply divided into two lobes; superior antennæ slender and filiform in both sexes; inferior antennæ in the male large, flat, curved downwards and two-jointed, resembling horns; in the female short, pointed and slightly curved; basal joint of male inferior antennæ provided with a short conical process.

A. salina. The Lymington shrimp or brine-worm. Found in the salt-pans at Lymington. Length about 1-2″.

Each segment of the thorax shortly bilobed at the apex, and with a pair of branchial feet; each lobe of the end joint of abdomen giving off several short setæ. Agrees generally in structure with *Branchipus*.

BIBL. Baird, *Brit. Entom.*; Rackett, *Linn. Trans.* xi.

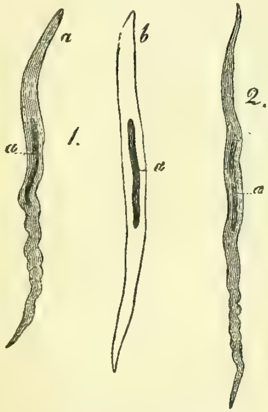
ARTERIES.—These are the tubes or vessels which convey the blood from the heart to the various parts of the body. The structure of the arteries is very complicated and difficult of investigation; and the coats or tunics of which they consist are so intimately connected as to be by no means easily separable.

In the *larger* arteries, three coats are usually distinguishable, an outer or adventitious coat, a middle and an inner coat. Their composition and thickness vary in arteries of different sizes.

The middle coat is usually thick and strong, consisting of several layers, and its elements run transversely. In the largest arteries it is yellow, very elastic and of great strength; as the vessels become smaller, it diminishes in thickness, becoming redder and more contractile; and near the capillaries it is very thin, finally disappearing. The inner coat is always thin, yet thickest in the large vessels; whilst the outer coat is absolutely thinner in these than in those of a moderate size, in which it equals or even exceeds the middle coat.

In the *smaller* arteries the inner coat consists of pale, flattened, fusiform cells with longish, oval nuclei; these possess no slight

Fig. 34.



Magnified 350 diameters.

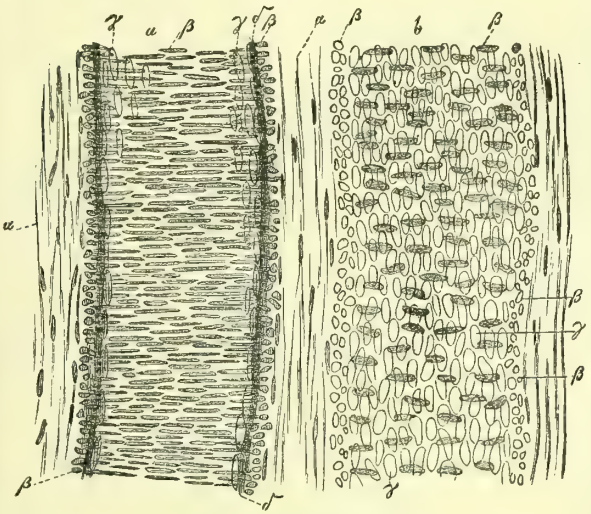
Muscular fibre-cells from human arteries. 1, from the popliteal; *a*, before, *b*, after the addition of acetic acid; 2, from a twig of the anterior tibial artery: *a*, nuclei.

resemblance, on the one hand, to the fusiform cells of pathologists (as also to the formative cells of elastic and areolar tissue), and on the other to contractile (smooth

muscular) fibre-cells; yet they differ from the former in the less acumination of their ends and their paleness, and from the latter in their rigidity, the form of their nuclei, and their chemical reactions.

An elastic layer is expanded beneath the epithelial layer in the living vessels, whilst in these, when empty, it exhibits numerous transverse or longitudinal folds. It forms what is called a fenestrated membrane, generally exhibiting more or less distinct reticulated fibres and usually small elongated openings; more rarely a very dense network of principally longitudinal elastic fibres, with narrow elongated fissures.

Fig. 35.



Magnified 350 diameters.

A small artery (*a*) and vein (*b*) (about 1-180″ in diameter) from the mesentery of a child, after the addition of acetic acid: *α*, external coat, with elongated nuclei; *β*, nuclei of the muscular fibres of the middle coat, partly seen from the surface, partly the sectional view; *γ*, nuclei of the epithelial cells; *δ*, fibrous layer of elastic tissue.

The middle coat of the smaller arteries is purely muscular. The fibres or fibre-cells, which are connected into layers, may be isolated by dissection, or by maceration and boiling in a mixture of nitric acid with four parts of water.

The outer coat consists of areolar tissue with elongated nuclei and fine elastic fibres, and is nearly as thick as, or even thicker than the middle coat.

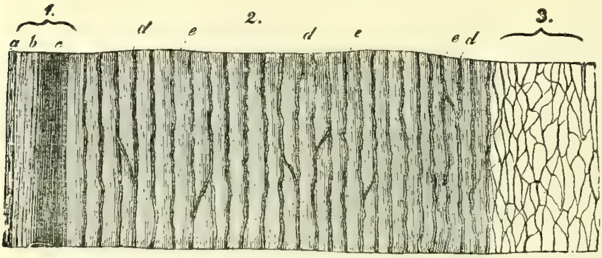
In the *smallest* arteries, the outer coat gradually ceases to contain elastic tissue, consisting merely of areolar tissue and the nuclei; this gradually loses its fibrous character, next becoming homogeneous, and finally a thin perfectly structureless membrane, and disappearing. In the same manner the middle coat gradually loses its layers of muscular fibres, until these and the fibres themselves ultimately vanish. On tracing the smaller arteries downwards, the inner coat is first found to lose its elastic fibres, and at last the epithelial cells cease to be isolable, all that can be distinguished consisting of their closely aggregated nuclei; but, by maceration in very dilute solution of nitrate of silver, the lines of demarcation of the cell-walls are rendered beautifully distinct.

In *moderate-sized* arteries the middle coat increases in thickness, but, in addition to a larger number of muscular layers, fine elastic fibres in open networks are added, at first running somewhat irregularly through the muscular elements, and in the larger vessels of this category mixed with areolar tissue, and here and there forming layers alternating with those of the muscular fibres. The inner coat sometimes contains between its elastic layer and the epithelium several other layers, forming, with fine networks of elastic tissue more externally situated in homogeneous granular or fibrillar areolar tissue, a strong middle layer, the elements of which are longitudinal. The outer coat in these vessels contains more elastic tissue, in the form of laminæ.

In the *largest arteries*, the epithelial cells of the inner coat are not so elongated, and the inner coat consists principally of layers of a homogeneous, striated, or even distinctly fibrillar substance, agreeing with areolar tissue, traversed by finer and coarser longitudinal networks of elastic tissue. Immediately beneath the epithelium the networks of elastic fibres are either very fine, or are replaced by one or more *striated layers*, which, when nucleated, often appear as if composed of fused epithelial cells, and when homogeneous resemble pale elastic

membranes. The middle coat contains, as a new element, elastic membranes or plates, as many as 50 or 60, which, except in their transverse direction, resemble the elastic inner coat, sometimes forming the densest networks of elastic fibres, at others fenestrated membranes. These layers alternate

Fig. 36.



Magnified 30 diameters.

Transverse section of the human aorta below the superior mesenteric artery, after acetic acid. 1. Inner coat: *a*, epithelium; *b*, striated layers; *c*, elastic layers. 2. Middle coat: *d*, its elastic layers; *e*, the muscular and areolar tissues; 3, outer coat with its network of elastic tissue.

with those of the muscular fibres traversed by areolar tissue and networks of elastic tissue. The muscular layer of the middle coat is less developed, its cells smaller and less regularly and perfectly formed.

The outer coat is relatively and absolutely thinner than that in the smaller; but the structure is the same, except that its inner elastic layer is much less developed.

In some of the larger arteries of man, as the axillary and popliteal, and the mesenteric arteries of other mammals, the internal coat contains unstriped muscular fibres. This is the case also with the outer coat of the larger arteries in animals, but not in man.

All except the smallest arteries are furnished with nutrient blood-vessels, the *vasa vasorum*; these ramify principally in the outer coat, in the larger ones extending into the middle coat. They also receive branches of the sympathetic and spinal nerves.

The most important pathological changes to which the arteries are subject, consist of the deposition of fat in their substance (fatty degeneration) and of atheromatous matter. These will be noticed under FATTY DEGENERATION and ATHEROMA. See VESSELS.

BIBL. Henle, *Allgem. Anat.*; Kölliker, *Handb. d. Gewebelehre*; Wedl, *Grundzüge der pathol. Histol.*; Rokitansky, *Ueb. einige d. wichtig. Krankh. d. Arterien*; Frey, *Histologie*, 1870, p. 363; Eberth (*Stricker's Handbuch*), v. p. 190.

ARTHO'NIA, Acharius.—A genus of Graphideæ (Gymnocarpous Lichens), distinguished by the small roundish or irregular apothecia, scattered over the thallus, devoid of an excipulum. Leighton describes eight British species, growing on the bark of trees, some of which have been described by others as species of *Opegrapha*, &c.

BIBL. Leighton, *Ann. Nat. Hist.* 1854, xiii. p. 436, pl. 7, 8; 1856, xviii. p. 330.

ARTHRIN'IUM, Kze.—A genus of Dematiei (Hyphomycetous Fungi), of which one species has been found in Britain, growing upon dead leaves of *Eriophorum angustifolium*.

A. sporophlœum, Kze. Filaments elongated, tufted, often not more than 1-50″ long, but frequently confluent in a linear form, with a kind of velvety surface; spores numerous, angular, or like a double cone, attached in whorls at the joints of the filaments.

BIBL. Berkeley, *Ann. Nat. Hist.* 1838, i. 436; *Torula Eriophori*, Berk. *Engl. Flora*, v. p. 2, 359; Fries, *Summa Veget.* p. 502.

ARTHROBO'TRYS, Corda.—A genus of Mucedines (Hyphomycetous Fungi) bearing elegant nodular groups of septate spores. No species is yet recorded in Britain. Corda describes one species, *A. superba* (fig. 37); in this the spores are about 1-1500″ long. Fresenius describes another, *A. oligospora*, perhaps not distinct, which has the erect filaments about 1-50″ high, solitary, not in tufts, and mostly with only one group of spores; these are pear-shaped, 1-700″ long, and have the septum below the middle: it was found on damp wood, fruit and earth, in a fungus-bed.

BIBL. Corda, *Prachtfl. eur. Schimmelb.* p. 43, t. 21; Fresenius, *Beitr. zur Mycologie*, Heft i. p. 18, pl. 3. figs. 1–8.

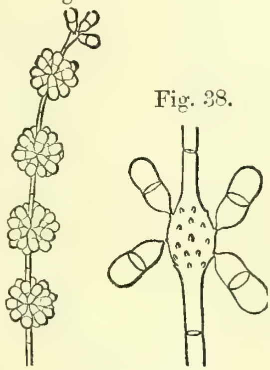
ARTHROBO'TRYUM.—A genus of Mucedines (Hyphomycetous Fungi), proposed by Cesati, characterized by a stem composed of jointed threads, bearing above large jointed radiating spores, so as to form a little head. They are beautiful microscopic objects. British species:—

1. *A. atrum*, B. & Br. On dead nettle-stems.

2. *A. stilboideum*, Ces. On a pollard willow.

BIBL. Berkeley, *Out. Br. Fung.* p. 342; *Hedwigia*, tab. 4. fig. 1.

Fig. 37. Fig. 38.



Arthrobotrys superba.

37. Fertile filament with many groups of spores. Magnified 200 diameters.
38. Fertile articulation of ditto, with most of the spores detached from the spine-like processes on which they are borne. Magnified 400 diameters.

ARTHROCLA'DIA, Duby.—A genus of Sporochnaceæ (Fucoid Algæ). *A. villosa*, Huds., is a rather rare British annual submarine species, growing in 4 to 5 fathoms water; bearing a curious pod-like nucleated fruit.

BIBL. Harvey, *Brit. Marine Algæ*, 2d ed. p. 24, pl. 5 C.; *Phyc. Brit.* t. lxiv.; *Eng. Bot.* t. 546; Derbès and Solier, *Ann. des Sc. Nat.* 3 sér. xiv. p. 33, figs. 18–20.

ARTHRODES'MUS, Ehr.—A genus of Desmidiaceæ.

Char. Cells single, compressed, constricted in the middle; segments entire, with a single spine on each side.

1. *A. convergens.* Segments elliptic (Pl. 10. fig. 27); length 1-598 to 1-539″.

2. *A. incus*, Bréb. Segments with truncated ends; length 1-1103″.

3. *A. minutus*, Kütz. (Pl. 43. fig. 9).

4. *A. truncatus*, Ehr.

5. *A. subulatus.*

Other species.

BIBL. Ralfs, *Brit. Desmid.* pp. 117, 200; Kützing, *Sp. Alg.* p. 176; Ehrenberg, *Infus.* p. 158; Rabenhorst, *Flor. Alg.* iii. p. 225.

ARTHROGY'RA, Ehr.—An obscure genus of Diatomaceæ.

A. guatemalensis (Pl. 42. fig. 8). Filament straight.

A. semilunaris. Filament curved. Both in Guatemala earth.

BIBL. Ehrenberg, *Mikrogeologie*, pl. 33.

ARTHROMI'TUS, Leidy.—Described as a genus of the Leptothriceæ of Kützing (Algæ Confervoideæ). Two species, *A. cristatus* and *A. nitidus*, were found in the intestinal canal of *Iulus marginatus*, a kind of millipede. These objects appear to have been imperfect forms of some filamentous Fungus. See PARASITIC FUNGI.

BIBL. Leidy, *On the presence of Entophyta in healthy living animals, Proc. Acad. of Philadelphia*, iv. p. 225, 1849, extracted in *Ann. Nat. Hist.* 2nd ser. v. p. 74.

ARTHRONE'MA, Hassall.—A genus of Oscillatoriaceæ (Confervoid Algæ).

A. cirrhosum (Pl. 4. fig. 20). Filaments of considerable size, striæ close, evident. Tufts widely spreading, filaments floating in bundles. In lakes at Lismore Island.

BIBL. Hassall, *Brit. Algæ*, p. 238.

ARTHROSI'PHON, Kützing. See PETALONEMA.

ARTICULI'NA, D'Orb.—Very narrow varieties of *Vertebralina*, which commence with a Milioloid (Triloculina) growth, and proceed with straight moniliform chambers, were separated by D'Orbigny under this name. Recent and fossil.

Articulina gibberula (Pl. 18. fig. 9 *a b*).

BIBL. D'Orbigny, *Ann. Sc. Nat.* vii. 300; Carpenter, *Introd. Foram.* 73.

ARTOTRO'GUS, Mont.—A genus of Sepedoniei (Hyphomycetous Fungi) containing one species growing and fructifying in the intercellular passages of germinating potatoes. This genus is supposed by Berkeley to be founded on a secondary form of fruit of some mould; probably of *Peronospora infestans.* See PERONOSPORA.

A. hydnosporus, Mont. Berkeley, *Journ. of Horticult. Soc.* i. p. 3, pl. 4. figs. 27–29; *Crypt. Botany*, p. 247.

A'RUM, L.—A genus of Araceæ (Flow. Plants). *Arum maculatum*, the common Cuckoo-pint, has a tuberous rhizome in which is produced much starch. This starch is extracted in the same way as Arrow-root starch is from the rhizomes of Marantaceæ &c., and is called Portland Arrow-root (Pl. 37. fig. 11). See STARCH.

AS'CARIS.—A genus of Entozoa, of the order Cœlelmintha and family Nematoidea.

Char. Body cylindrical, narrowed at each end; head furnished with three tubercles or

valves; mouth terminal, situated between the three tubercles; male with one or two spicula.

The species are very numerous, occurring in all the classes of the Vertebrata and doubtfully in Insects. They are most commonly found in the alimentary canal. We shall only notice the species met with in man.

1. *A. lumbricoides.* The common round worm. Inhabits the human small intestine; sometimes found also in that of the ass, wild-boar, pig and ox. Varies in length from 3 to 15″; is of a whitish colour; the head distinct, with the three valves (Pl. 16. fig. 9) finely denticulated on their inner border, and each furnished near the summit with a slightly projecting papilla. Female larger and more common than the male. Spicula two, equal.

The recent ova are surrounded by an albuminous layer, the surface being studded with numerous projecting tubercles.

2. *A. vermicularis* (*Oxyuris verm.*). The human thread-worm. Found usually in the rectum. White; head frequently appearing winged, or exhibiting two lateral vesicular expansions (Pl. 16. fig. 8 *a*), produced by endosmosis. Mouth round when contracted, exhibiting the three lobes when expanded. Œsophagus (*e*) containing a triquetrous canal, and separated by a constriction from the spherical stomach (*d*). Length, female 3 to 4-10 of an inch; male shorter, with the tail spirally coiled, much more rarely met with. Anus (*g*) about 1-8 from the end of the body; spiculum single, with an appendage. Uterus consisting of two lobes (*h*) (ovaries); oviduct (*k*) opening externally near the middle of the body.

3. *A. mystax* (*alata*, Bell), 2 to 3 inches long, as broad as a crow-quill; common in the cat, occasional in the human body.

BIBL. Dujardin, *Helminthes*; Leuckart, *Mensch. Parasit.* ii. p. 153; Cobbold, *Entozoa*, p. 302; Sieb. & Köll. *Zeitschr. passim.*

ASCID'IA, Bast.—A genus of Tunicate Mollusca, of the family Ascidiadæ.

Several British species. See ASCIDIADÆ.

ASCID'IADÆ.—A family of Tunicate Mollusca.

Distinguished by their being single, usually fixed (to foreign bodies, as seaweeds, shells, &c.), and the attachment of the mantle to the test at the orifices only.

Irregularly shaped, from half to several inches long, often incrusted with stones and shells, &c.; with two orifices, one branchial and pharyngeal, the other anal. Genera:

1. *Ascidia*, Bast. Test leathery; branchial orifice eight-lobed, anal six-lobed, both circular; branchial sac not plaited.

2. *Molgula*, Forbes. Globose, attached or free; test membranous, usually covered with foreign matters; branchial orifice six-lobed, anal four-lobed, both on contractile naked tubes.

3. *Cynthia*, Sav. Sessile; test leathery; branchial sac plaited longitudinally; both orifices four-sided.

BIBL. Forbes and Hanley, *Brit. Mollusca*, i. 29; Gosse, *Mar. Zool.* ii. 35.

ASCLEPIADA'CEÆ.—A family of Dicotyledonous flowering-plants, presenting some remarkable characters in the pollen (see POLLEN). The stems of some of these plants contain very tenacious fibres, which have been used for economical purposes (see FIBRES, vegetable).

ASCOB'OLUS.—A genus of Helvellacei, distinguished from *Peziza* by the asci being projected from the hymenium at maturity. *Ascobolus furfuraceus* is only common on cow-dung; but there are numerous other British species. The sporidia are often beautiful microscopic objects (see Cooke, in *Seemann's Journ. Bot.* May 1864).

ASCOMY'CES.—A genus of Ascomycetous Fungi, characterized by the absence of any receptacle, the asci forming a thin pulverulent stratum. All the species are parasitic on living leaves or young shoots. It is the lowest form to which Ascomycetes can be reduced. British species:

1. *A. bullatus.* On pear-leaves.
2. *A. deformans.* On peach-leaves, producing a form of blister.
3. *A. trientalis.* On leaves of *T. europæa.*
4. *A. juglandis.* On walnut-leaves.
5. *A. carnosa.* On *Rhododendron ferrugineum*, producing large gall-like excrescences.

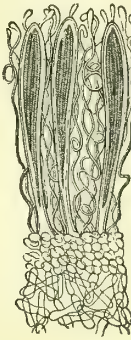
BIBL. Berkeley, *Journ. Hort. Soc.* vol. ix. p. 48; *Outl. Br. Fung.* p. 376.

ASCOMYCE'TES.—An order of Fungi characterized by producing the spores in tubular sacs (*asci* or *thecæ*), frequently intermixed with empty filiform sacs (*paraphyses*) (fig. 40), and hence bearing a near relation to the Lichens, which, indeed, are included under this order by some botanists; but the existence of green colouring-matter in the cells, and of *gonidia* or brood-cells, in the Lichens, forbids such an association. The Ascomycetes differ much in external form, and approach in this particular several tribes belonging to the other orders; thus

the Tuberacei are very much like many of the Gasteromycetes, the Helvellacei like

Fig. 39.

Fig. 40.



Spathulea flavida.

Fig. 39. Entire plant (reduced).

Fig. 40. Highly magnified section of fructification, showing asci and paraphyses arising from the hymenium.

some Hymenomycetes, &c., differing chiefly in the mode of the production of the spores (figs. 39–42).

Fig. 41.

Fig. 42.

Leotia geoglossoides.

Fig. 41. Group of plants (reduced).

Fig. 42. Highly magnified asci with spores.

The Onygenei are little Fungi growing on dead animal substances, feathers, horn, &c., and have a flocculent mycelium, bearing little columnar bodies terminating in a thickened head—the sporange, which is a kind of hood falling off at maturity. The sporiferous structure, loosely filling up the hood, is composed of interlacing branched filaments, bearing at their free ends globular cells (*asci* or *thecæ*) filled with spores.

The Perisporiacei are likewise very simple, consisting of parasitical Fungi growing upon the leaves of trees or herbaceous plants. They have a flocculent mycelium, often radiating from a centre, where is found a membranous, sac-like, globular sporange, containing sometimes a definite, sometimes an indefinite number of clavate sacs or *asci*, alone or mingled with paraphyses, and containing ovate spores. The sporange bursts either regularly or irregularly at the summit.

The Sphæriacei have the conceptacles more developed, either single, or associated on a common receptacle, and consisting of a firm capsular structure, lined with *asci*, and opening at the apex by a regular pore in the form of a papilla or beak when mature.

The Phacidiacei differ chiefly in the dehiscence by slits, either single and longitudinal, or several and parallel or stellate, or circular so as to detach a lid; most of these have the sporanges collected on a common receptacle, either of horny or fleshy consistence.

In these two tribes, and in Helvellacei, Coniomycetous forms of spore are found upon the same receptacle, either contemporaneously or at different stages of development. Attention is directed to this subject under the head of that order; and more will be found under SPHÆRIA, TYMPANIS, RHYTISMA, DOTHIDEA, CORDICEPS, &c.

The true Tuberacei are Ascomycetous representatives of the Hypogæous Gasteromycetes, being subterraneous, solid, globular or lobed bodies, of fleshy consistence, the Truffle being a well-known example. The organization of the Tuberacei is analogous in all cases, but the structures differently arranged. They all have an inconspicuous flocculent mycelium, from which arises the solid sporange. The sporange exhibits, when cut across, an outer tough coat (*peridium*), enclosing a fleshy structure excavated with sinuous cavities giving it a marbled appearance. These sinuous cavities are produced by the convolutions of the fructifying layer, which is folded and reflected backwards and forwards, leaving interstices which are lined with the *asci* or spore-sacs containing four or eight spores. The degree of complexity of the lacunose mass differs in different genera, being in some simple, in others very complicated.

The sporanges of the Helvellacei vary much in form, the simpler resembling closely some of the Phacidiacei: some kinds are minute fleshy cups lined with asci forming a superficial layer, as in *Propolis*; or

they are large fleshy cups, often raised on a stalk (*Peziza*), these cups being closed at first, but opening widely afterwards. In the *Helvellæ*, the cup is converted into a stalked mitre-shaped body clothed above with *asci*. Others are of columnar form, thickened at the summit, which is clothed with the asci, as if a cup-shaped receptacle had been turned down over it (*Spathulea*, fig. 39)—this thickened head becoming more considerable and excavated into little pits in *Morchella*. These plants are mostly found on the ground or decaying vegetable substances, in damp places, and are frequently of gelatinous consistence.

If a *Peziza*, *Morchella*, *Rhytisma acerinum*, or similar Fungus, in its last stage of development, is kept shut up in a bottle for several hours, and then gently taken out, the contact of the external air causes an immediate and abundant explosion of spores, which may be collected on slips of glass for microscopic examination. If care is taken in the experiment, it will be found that a considerable quantity of a colourless liquid is expelled with the spores, which liquid contains minute molecules, and evaporates very rapidly, leaving more or less apparent spots on the glass. See SPHÆRIA.

Synopsis of the Families.

1. HELVELLACEI. Fruit fleshy, of various forms, ultimately expanded, clavate, capitate, stalked, mitre-shaped, cup-shaped or bell-shaped, the upper surface clothed by elongated sacs (asci), each containing eight simple or septate spores.

2. TUBERACEI. Fruit (subterraneous) globular, with an adherent peridium; solid and fleshy within, and excavated sinuously into numerous cavities clothed by asci containing four or eight spores; the internal mass drying up or becoming pulverulent or floccose when mature.

3. PHACIDIACEI. Fruit fleshy, simple or branched, more or less cup-shaped in the sporiferous region, which opens widely or by a slit when mature, and exposes a cavity lined with elongated asci mixed with paraphyses.

4. SPHÆRIACEI. Fruit usually forming a common, often horny, receptacle, in which are excavated conceptacles, lined with asci, opening by a terminal pore.

5. PERISPORIACEI. Common receptacle floccose, radiating from a centre, bearing conceptacles free or surrounded by filaments, opening by a terminal pore, with asci attached at the base filled with simple ovate spores.

6. ONYGENEI. Mycelium floccose, bearing capitate, stalked sporanges, which open by a circular slit at the base, causing the upper part to fall off like a cap; exposing a fructifying mass composed of interlacing branched filaments, bearing globular asci at the free extremities of the branches.

BIBL. See under the heads of the Families.

ASCOPH'ORA, Tode. See MUCOR.

ASCOT'RICHA, Berk.—A genus of Perisporiacei (Ascomycetous Fungi), containing one species.

A. chartarum, a kind of mildew growing on paper, forming a brownish, angularly and dichotomously branched mycelium, from which arise globose, black, hairy peridia containing linear asci, each containing a single row of chocolate-coloured spores. Peridia from 1-20 to 1-30″ in diameter.

BIBL. Berkeley, *Ann. Nat. Hist.* 1838, i. 257, pl. 7. fig. 8.

AS'CUS.—The term applied to the cylindrical globose or clavate tubular sac forming the parent cell of the spores in the Ascomycetous or Thecasporous Fungi. It is frequently called a *theca* also (figs. 40 and 42). Asci consist of a double membrane, the inner often visibly projecting when the ascus is broken across. A little lid is frequently separated from the apex when the sporidia are discharged, as in *Ascobolus*, in which genus the asci are shot out from the common hymenium. See ASCOMYCETES.

BIBL. *Mag. of Zool. & Bot.* vol. ii. p. 222; *Pringsh. Jahrb.* Bd. i. p. 189.

ASEL'LUS, Geoffroy (the water woodlouse).—A genus of Crustacea, of the family Isopoda.

Char. Antennæ four, outer much longer than the inner ones; legs shorter than the body, the first pair not chelate; two posterior projecting bifurcate abdominal appendages.

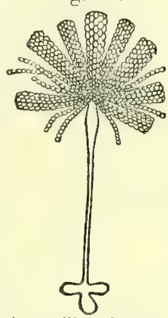
A. vulgaris (Pl. 43. fig. 13). Length 1-4 to 1-2″ or more. This animal is particularly interesting to the microscopist, on account of its forming the most readily procurable object for examining the dorsal vessel and circulating liquid in motion. It is found in almost all stagnant waters. The currents of the circulating liquid, with the colourless corpuscles, are readily seen streaming through every part of the body. Beneath the large scutiform joint of the body (the abdomen), are three flattened branchial false legs or gills on each side,

covered by two jointed gill-covers; these are in almost constant motion during life.

Bibl. Desmarest, *Consid. Général. s. l. Crustacés*; Treviranus, *Vermischte Schriften*, i.; M.-Edwards, *Crustacés*, iii. (*Suites à Buffon*).

ASPERGIL'LUS, Micheli.—A genus of Mucedines (Hyphomycetous Fungi) forming common moulds, such as the blue mould of cheese, *A. glaucus*. The chains of spores arise from a more or less globular head at the apex of the fertile filaments (fig. 43). It is often stated that the heads of spores are originally enclosed in a peridium; according to our observations this is not the case; the spores bud out from the capitular cell, which enlarges very much during the formation of the head of spores; and when these have been detached, the head is left bare, but covered with short spiny processes (the points of attachment of the chains of spores), and then looks something like a young peridium of *Mucor*. *Aspergillus* has been found to produce a secondary form of fruit, being that forming the subject of the genus Eurotium. British species:

Fig. 43.



Aspergillus glaucus. A fertile filament with chains of spores on a globular head. Magnified 50 diameters.

* *Fertile filaments simple.*

1. *A. glaucus*, Link. Sporidia globose, variable, white to glaucous, close (*A. candidus*, Link) or lax. Heads about 1-100″ in diameter when mature. On cheese, lard, bread, &c., very common (fig. 43). It has been found also in the lungs and air-cavities of birds, *Mucor glaucus*, L.

2. *A. roseus*, Lk. Sporidia globose, very small, rose-red; fertile filaments not septate. On damp paper, lint, carpet, &c.

3. *A. aureus*, Berk. Sporidia large, elliptical, thinly scattered, golden-yellow; fertile filaments without septa. On bark. Now referred with *A. aurantiacus*, from which it scarcely differs, to the genus *Rhinotrichum*.

4. *A. aurantiacus*, Berk. Sporidia oval, the lowest of the chain much larger, mycelium rusty orange, the heads often proliferous, so as to produce a complicated mass. On bark. *Ann. Nat. Hist.* vi. p. 436, pl. xiii. 22. *Nematogonium aurantiacum*, Desmaz. *Ann. des Sc. Nat.* 2 sér. ii. p. 69, pl. 2. fig. 1.

** *Fertile filaments branched.*

5. *A. maximus*, Lk. Sporidia very large, at length yellow brown, mycelium a fleecy mass of the same colour; fertile filaments dichotomous, clavate above. On decaying Fungi.

6. *A. mollis*, Berk. Sporidia large, subglobose, white, mycelium white; fertile filaments dichotomous, standing in minute, scattered, white bundles.

7. *A. virens*, Lk. Sporidia, like the filaments, greenish; tufts of fertile filaments rather dense, entangled, suberect. On decaying fungi and other bodies.

8. *A. alternatus*, Berk. Sporidia grey-black, subtruncate; fertile plants branched alternately in a zigzag manner, erect or decumbent, forming extremely minute orbicular patches on damp paper. *Ann. Nat. Hist.* 1838, i. p. 262, pl. 8. f. 11.

9. *A. dubius*, Corda, would appear to differ generically from the above. Mr. Berkeley states that its capitular cells bear linear processes, each surmounted by four sterigmata, on which are attached the chains of spores. On dung. Corda, *Icones*, ii. t. 11. fig. 77.

Bibl. Berkeley, *Hooker's Br. Flora*, ii. part 2. p. 339; *Ann. Nat. Hist.* i. 262, vi. 436, 2nd ser. vii. 100; *Crypt. Bot.* p. 298; Fries, *Syst. Mycolog.* iii. 383; Corda, *Icon. Fung.*; Robin, *Veg. Parasites*, p. 515.

ASPEROCOC'CUS, Lamour.—A genus of Dictyotaceæ (Fucoid Algæ), of which three species are found on the British coast.

Fig. 44.

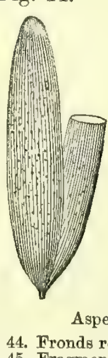


Fig. 45.

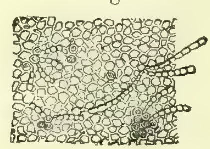
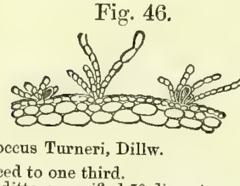


Fig. 46.



Asperococcus Turneri, Dillw.

Fig. 44. Fronds reduced to one third.
Fig. 45. Fragment of ditto, magnified 50 diameters.
Fig. 46. A section at right angles to fig. 45, showing the sporanges and paraphyses, magnified 50 diameters.

The fructification consists of groups of sporanges (commonly called spores), intermixed with paraphyses, scattered over the whole surface of the frond. When mature these sporanges discharge zoospores.

BIBL. Harvey, *Br. Marine Algæ*, 2nd ed. p. 42, pl. 8 C.; *Phyc. Brit.* t. xi., lxxii. and cxciv.; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 238; Derbès and Solier, *ibid.* p. 268, pl. 33. fig. 11.

ASPIDIE'Æ.—A subtribe of Polypodioid Ferns, with indusiate sori.

Illustrative Genera.

1. *Lastræa.* Indusium reniform, veinlets free at the ends.

2. *Nephrolepis.* Indusium reniform; sori on the tips of the upper veinlets, which are shorter and arise from the base of the veins; petioles articulated with the rachis.

3. *Nephrodium.* Indusium reniform, veinlets inosculating.

4. *Aspidium.* Indusium orbicular, peltate; veins much branched, anastomosing in hexagonal areolæ, with free veinlets.

5. *Polystichum.* Indusium orbicular, peltate; sori on the middle of the veins below the bifurcations.

6. *Sagenia.* Indusium orbicular, peltate; veinlets anastomosing in hexagonal meshes, without free veinlets.

7. *Fadyenia.* Indusium cordate; sori apical, biseriate; veinlets reticulate.

8. *Didymochlæna.* Indusium oblong-elliptic, fixed in the middle by a longitudinal crest.

9. *Matonia.* Indusium orbiculate, peltate, umbonate, the margins deflexed, covering about six sporanges.

BIBL. See FILICACEÆ.

ASPIDIS'CA, Ehr.—A genus of Infusoria, of the family Aspidiscina.

Char. That of the family.

1. *A.* (*Trichoda*, Müll.) *lynceus* (Pl. 23. fig. 15 *a*, under view). Carapace suborbicular, truncated posteriorly, uncinate anteriorly; aquatic, among *Confervæ* &c.; length 1-1100 to 1-560″.

2. *A. denticulata* (Pl. 23. fig. 15 *b*, side view). Carapace suborbicular, rounded at the ends, truncate and denticulate on the left side; aquatic; length 1-560″. See OXYTRICHA.

BIBL. Ehrenb. *Infus.*; Duj. *Infusoires*; Stein, *Infusionsthiere* &c.

ASPIDISC'INA, Ehr.—A family of Infusoria.

Char. A carapace present in the form of a transparent flattened shield, projecting beyond the mouth in front; flexible bristles on the ventral surface of the body, with delicate oral cilia.

Ehrenberg describes an alimentary canal, the inferior orifice of which alone is terminal. Hence they correspond to *Euplotes*, with the excrementitial orifice terminal.

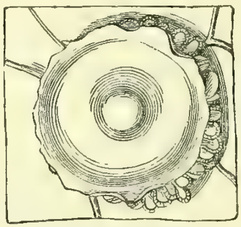
Dujardin places them among his *Coccudinæ.*

The setæ, styles or cirri serve for climbing, whilst by the cilia the animals are enabled to swim.

This family should not be retained; but the single genus of which it is constituted, *Aspidisca*, referred to the Euplota.

ASPID'IUM, Schött.—A genus of Aspidieæ (Polypodioid Ferns), in its old sense including many of our native species, but now broken up into subdivisions, raised to the rank of genera.

Fig. 47.



Aspidium trifoliatum.
An indusium covering a sorus.

Fig. 48.

Aspidium trifoliatum.
Side view, cut through perpendicularly.
Magnified 25 diameters.

ASPLANCH'NA, Gosse.—A genus of Rotatoria, of the family Hydatinæa.

Char. Foot, intestine, and anus absent; eye-spots (1 to 3) and mandibles present; sexes separate.

1. *A. Brightwellii* (*Notommata Syrinx*, Ehr.?). Female: jaws with a single tooth; eye-spot single; tremulous bodies attached to an extended filament; aquatic; length 1-24″. Male: jaws, pharynx and stomach absent; body truncate; length 1-40″.

2. *A. priodonta* (Pl. 34. fig. 7, female). 3 eye-spots; tremulous bodies attached to a tortuous filament; aquatic; length—female 1-48″, male 1-110″; jaws of female serrated (7 *b*).

Bibl. Brightwell, *Ann. Nat. Hist.* ser. 2. ii. p. 153, pl. 6; Dalrymple, *Trans. Roy. Soc.* 1849, and *Ann. Nat. Hist.* 1849, iii. p. 518; Gosse, *Ann. N. H.* 1850, vi. p. 18, viii. p. 197.

ASPLENIE'Æ.—A subtribe of Polypodioid Ferns with indusiate sori. The following genera are indigenous or readily met with cultivated.

Illustrative Genera.

1. *Scolopendrium.* Veins pinnate; sori linear, in pairs on the adjacent sides of two parallel veinlets.
2. *Antigramma.* Veins pinnate, veinlets anastomosing; sori linear, in pairs facing together.
3. *Camptosorus.* Veins pinnate, veinlets anastomosing; sori elongated, diverging.
4. *Diplazium.* Veins pinnate, veinlets free; sori linear, in pairs back to back.
5. *Oxygonium.* Veins pinnate, veinlets anastomosing at the ends; sori linear, in pairs back to back.
6. *Asplenium.* Veinlets free; sori linear, single on the back of a vein or veinlet.
7. *Ceterach.* Indusium replaced by abundant scales; sori linear on the back of veins.
8. *Neottopteris.* Veinlets anastomosing at the ends; sori linear, single.
9. *Blechnum.* Sori marginal, more or less confluent; indusium opening inwards.
10. *Athyrium.* Veins pinnate; sori straight, curved or reniform, but attached by a linear edge.
11. *Doodia.* Veins parallel, anastomosing slightly; sori lunate or linear, in one or two rows parallel with the midrib; indusium flat.
12. *Woodwardia.* Veinlets forming hexagonal meshes; sori lunate or linear, parallel with the midrib, in one row; indusium convex, immersed.
13. *Cystopteris.* Indusium suborbicular, fixed by a lateral inferior point.
14. *Onoclea.* Fertile pinnæ contracted into globules; indusium lunate, attached on a short horizontal veinlet.

Bibl. See Filicaceæ.

ASPLE'NIUM, Presl, *Spleen-wort.*—A well-known genus of Asplenieæ (Polypodioid Ferns), containing a number of indigenous species.

ASSILI'NA, D'Orb.—A variety of *Nummulina* (grouped as a subgenus), in which the alar lobes are reduced to a minimum, and thereby the faces of the shell are left unthickened, except perhaps at their centres; and nearly or quite all the whorls are exposed. These shells are the *Nummulinæ explanatæ* of D'Archiac and Haime. *Assilina exponens*, Sow., sp., is the best type of this subgenus of *Nummulina*. It abounds, with the more perfect type, in the older Tertiary strata of Switzerland and India.

Bibl. D'Orbigny, *Ann. Sc. Nat.* vii. 296 (the Modèle 88 here referred to, however, is an *Operculina*); D'Archiac and J. Haime, *Foss. Ann. de l'Inde*; Parker and Jones, *Ann. N. H.* ser. 3. v. 110, and viii. 232.

ASTA'SIA, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. Unattached, no eye-spot. Ehrenberg adds, a longer or shorter tail. Dujardin says, with a flagelliform filament, which is not expanded at the base, but arises suddenly from the anterior part of the body, or from a more or less deep notch in it.

Dujardin forms an unnecessary genus, *Peranema*, to contain those species in which the filament arises from the gradually narrowed anterior extremity of the body.

1. *A. hæmatodes*, E. (Pl. 23. fig. 16). Fusiform, tail very short; at first green, then red; length 1-380″.

The flagelliform filament was absent in the specimens represented in the figure. The substance of the body was insoluble in caustic potash, even when heated to boiling, merely becoming swollen. It exhibited numerous vacuoles, which in some of the organisms were filled with green grains of chlorophyll. The colour arose from distinct granules of pigment, scattered through the colourless substance; when treated with solution of iodine and then sulphuric acid, the *Astasiæ* became spherical, and were coloured blue, bluish green and purplish blue, the purple tint apparently indicating the presence of cellulose. It was, however, afterwards found that these colours were produced by the acid alone (see Pl. 25. fig. 25).

This curious organism colours the water of ponds &c. blood-red.

2. *A. limpida*, D. (Pl. 23. fig. 17). Fusiform, colourless; length 1-550″.

There are other species; but they are ill-

defined. *A. nivalis*, Shuttleworth, found in red snow, would appear to be an active form of *Protococcus nivalis*.

BIBL. See ASTASIÆA; also Shuttleworth, *Biblioth. de Genève*, Feb. 1840.

ASTASIÆ'A, Ehr.—A family of Infusoria.

Char. Body of spontaneously variable form, mostly with one or more flagelliform filaments. (Insoluble in solution of caustic potash.)

This family corresponds nearly to the Euglenia of Dujardin, who asserts the existence of a contractile integument. Form of the body variable, sometimes becoming spherical, at others cylindrical, fusiform, &c., and exhibiting a head- or tail-like process, or both. In two genera, *Colacium* and *Distigma*, the presence of the filament is doubtful. The Astasiæa are distinguished from the Amœbæa by the absence of the irregular processes sent out by the latter from all parts of the body.

The forms included under the family thus characterized are still very imperfectly understood; and it is probable that some of them, separated generically by Ehrenberg, are only transitional conditions of others. Infusoria exactly resembling *Astasia hæmatodes* and *Euglena viridis* occur without the flagelliform filament; *Euglena* also occurs in a resting form, surrounded by a gelatinous envelope, like *Chlamidomonas*, and undergoes division into 4, 8, 16 or more new individuals in this state, so as to form irregular, floating Algoid patches. The green bodies make their escape from the gelatinous envelopes under certain circumstances, just in the same way as the zoospores escape from the cells of the Confervoid Algæ. This resting form also exhibits another character, especially in winter; the gelatinous envelope acquires a firm, dense, membranous coat over its periphery, like the resting spores of the Confervoids, and in some cases this coat is polygonal and marked with ridges &c. It is probable that the colour of the species is not constant, since it seems to depend upon similar substances to that of the Palmellaceæ, which are known positively to change from green to red, and *vice versâ*, and even to fade into an almost colourless state when kept in the dark. These organisms still require much careful examination, not of isolated specimens, but by watching their developmental history constantly for extended periods and through different seasons. More is said on this subject under PROTOCOCCUS.

The following Table gives the genera of Ehrenberg and Dujardin:—

Attached	*Colacium*, Ehr.
Unattached.	
No flagelliform filaments, 2 eye-spots	*Distigma*, Ehr.
One flagelliform filament.	
One eye-spot.	
With a tail-like process	*Euglena*, Ehr.
Without "	*Amblyophis*, Ehr.
No eye-spot	*Astasia*, Ehr. (& *Peranema*, Duj.).
Two flagelliform filaments.	
Both alike.	
Animals green, with a red eye-spot	*Chlorogonium*, E.
Colourless, no eye-spot	*Zygoselmis*, Duj.
One anterior, the other trailing and retractile	*Heteronema*, Duj.
Several filaments	*Polyselmis*, Duj.

BIBL. Ehrenberg, *Infus.*; Dujardin, *Infus.*; Morren, *Sur la Rubéfact. des Eaux*, Brux. 1841; Cohn, *Protococ. pluv.*, *Nova Acta Ac. L. C. N. C.* xxii. p. 397. (Abstr. *Ray Soc. Botan. Papers*, 1853, p. 352.)

ASTATHE. See PRIMORDIAL UTRICLE.

ASTERIGERI'NA, D'Orb.—A pseudo-genus of Foraminifera, comprising species of both *Rotalia* and *Discorbina*, that have star-like patterns on one face of the shell. In some *Rotaliæ* an astral arrangement of subsidiary chamberlets around the umbo is formed as in *Amphistegina*; and in several *Discorbinæ* the deep radiating sulci around the umbilicus are roofed over with distinct, more or less perfect plates of shell.

BIBL. Carpenter, *Introd. Foram.* 204, 213.

ASTERIONELLA, Hass.—A genus of Diatomaceæ (Cohort Fragilariæ).

Distinguished by the inflation of one or both ends of the frustules, and the adherence of their adjacent angles into a stellate form.

Doubtless the frustules are originally parallel, forming a straight filament.

1. *A. formosa* (Pl. 43. fig. 14). Frustules 4–8; in the front view somewhat more enlarged at the attached than the free end. Aquatic; length 1-384''.

2. *A. Ralfsii.* Frustules linear; valves attenuated towards one end, constricted towards the other, which is rounded and capitate. Aquatic; length 1-555''.

3. *A. Bleakeleyii.* Frustules linear, enlarged at the base. Marine; length 1-454''.

2 other species.

BIBL. Hassall, *Micr. Exam. of London Water*; Smith, *Brit. Diat.* ii. 81; Greville, *Ann Nat Hist.* 1865, xvi. p. 4; Rabenhorst, *Flor. Alg.* i. p. 141.

ASTERODIC'TYON, Ehr. (*Ber. d. Berl. Akad.* 1845). See Monaclinus.

ASTERODIS'CUS, Johnson.—A genus of fossil Diatomaceæ, allied to *Asterolampra* and *Asteromphalos*; but distinguished by one septum dividing halfway from the centre, and proceeding to two of the compartments, the intermediate smooth ray being smaller than the others. 3 species; rays from 5 to 9.

Bibl. Johnson, *Silliman's Journal*, 1852, xiii. p. 33.

ASTEROLAMP'RA, Ehr.—A genus of fossil Diatomaceæ.

Char. Free; circular; central portion divided by thin septa, which do not reach the margin, but alternate with rays extending to the margin, unsupported by septa; fossil. Intermediate between *Actinocyclus* and *Actinoptychus*.

A. marylandica (Pl. 19. fig. 5). Marginal rays eight, septa eight; interstices between the rays exhibiting elegant curved series of dots; diam. 1-180''. Found fossil in Maryland.

Bibl. Ehr. *Ber. de Berl. Akad.* 1844, p. 73; Greville (*Monogr.*), *Mic. Trans.* 1860, p. 102; 1862, p. 41; 1863, p. 227; 1865, p. 99.

ASTERO'MA, D.C.—A genus of Sphæronemei (Coniomycetous Fungi) growing upon leaves and stalks, forming very minute, slightly prominent coloured or black spots, more or less confluent, seated on more or less distinct radiating filaments. Fries separates part of the species under the name of *Actinonema*. Species:

1. *A. reticulatum*, D.C. *Dothidea reticulata*, Fr., Corda. On decaying leaves of *Convallaria*. Hooker, *Brit. Flora*, ii. part 2. p. 288.

2. *A. Ulmi*, Klotsch. On elm-leaves. Hooker, *Brit. Flora*, ii. part 2. p. 289.

3. *A. Prunellæ*, Purt. On green leaves of *Prunella vulgaris*. Hooker, *Brit. Fl.* ii. part 2. p. 289.

4. *A. Padi*, Grev. On *Prunus Padus*. Hooker, *Brit. Fl.* ii. pt. 2. p. 289; Berkeley, *Ann. Nat. Hist.* vi. 364, pl. 11. fig. 4.

5. *A. Rosæ*, Lib. On rose-leaves. Libert, *Trans. Linn. Soc. of Paris*, 1826; Berkeley, *Ann. Nat. Hist.* vi. p. 364, pl. 11. fig. 5.

6. *A. labes*, Berk. On poplar leaves. Berkeley, *Ann. Nat. Hist.* vi. 364, pl. 11. fig. 6.

7. *A. Veronicæ*, Desm. Berkeley, *Mag. Zool. & Bot.* i. p. 511.

Bibl. Fries, *Summa Veget. Scan.* 424.

ASTEROM'PHALOS, Ehr.—A genus of Diatomaceæ.

Resembles *Asterolampra*, except that two of the central septa are parallel, and one of the marginal rays absent or almost obliterated.

The species occur in the Antarctic ocean; the diameter of the valves lies between 1-900 and 1-47''. They are distinguished by the number and direction of the central rays.

A. Darwinii. Central rays five, flexuous.

A. Hookerii (Pl. 19. fig. 2). Central rays six, marginal five, straight.

A. Rossii. Rays six, inflexed.

A. Buchii. Rays six, straight.

A. Beaumontii. Rays seven, inflexed (Pl. 43. fig. 15).

A. Humboldtii. Rays eight, straight.

A. Cuvierii. Rays nine, straight.

Bibl. Ehr. *Ber. d. Berl. Akad.* 1844.

ASTEROPH'ORA, Dittm.—A genus of Sepedoniei (Hyphomycetous Fungi), composed of minute fibrous plants, growing parasitically upon dry blackened Agarics, deriving their name from the angular, somewhat stellate spores; now shown by Tulasne to be the conidiiferous state of a species of Hypomyces. Two British species are described:

1. *A. agaricoides*, Fr. Stipe solid, 1'' high, 1''' or more thick, villous, bearing a head, at first hemispherical, then plane, about 1-2'' wide, at first covered by a white fugacious tomentum, with lamellæ underneath; spores 6-angled. On decaying Agarics (*A. adustus, piperatus*), in autumn, gregarious. *A. lycoperdioides*, Dittm. *Sturm's Deutsch. Fl.*

2. *A. lycoperdioides*, Fr. Stipe 1'' high or obsolete; head hemispherical or globose, without lamellæ beneath; spores 5–6-angled. In similar situations, rather more common. *Agaricus lycoperdioides*, Sow.

Bibl. Hook. *Br. Fl.* ii. part 2. 322; Sowerby, *Fungi*, t. 279; Sturm, *Deutschl. Fl.* iii. t. 26; Bulliard, *Herb.* t. 166, 516, fig. 1; Tulasne, *Carpologia*, iii. p. 54.

AS'TEROTHRIX, Ktz.—An obscure genus of Algæ.

Char. Filaments indistinctly jointed, greenish, very rigid, stellately branched, acutely cuspidate at each end, floating.

3 species: fresh water.

Bibl. Kützing, *Phyc. Gen.* p. 200; Rabenhorst, *Flor. Alg.* iii. p. 391; Perty, *Kleinst. Lebensf.* 216.

AST'OMUM, Hampe.—A genus of Bru-

chiaceæ (Acrocarpous Mosses), including some of the *Phasca* of Linnæus, &c.

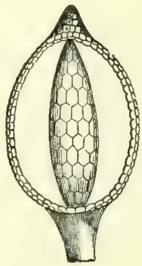
1. *A. subulatum*, Hmp. = *Phascum subulatum*, L. (fig. 49).

2. *A. alternifolium*, Hmp. = *Ph. alternifolium*, Dicks, *Crypt.* (fig. 50).

Fig. 49.

Astomum subulatum.
A leaf, showing the cellular structure.
Magnified 40 diameters.

Fig. 50.



Astomum alternifolium.
Section of sporange.
Magnified 40 diameters.

3. *A. nitidum*, Hmp. = *Ph. axillare*, Dicks.

Bibl. Müller, *Syn. Muscor.*; Wilson, *Bryol. Brit.* p. 24.

ASTRORHI'ZA, Sandahl.—A relatively large Rhizopod, related to *Lituola*. Varying from sphæroidal to irregularly star-shaped, and having sometimes a disk $\frac{1}{6}$ inch broad, besides radii or digitated branches. Its test is arenaceous and thick, without any large aperture, the pseudopodia being extruded from between its constituent sand-grains.

Bibl. Sandahl, *Öfvers. Vet. Akad. Förhandl.* 1857, p. 299; Carpenter, *Proc. Roy. Soc.* 1869, p. 289.

ATAX, Dugès.—A genus of Arachnida, of the order Acarina, and family Hydrachnea.

Char. Body ovoid; a genital fissure bordered by two plates, upon each of which are three transparent rounded tubercles; anterior coxæ posteriorly in contact in the median line, wedging the labium between them anteriorly; the two groups of posterior coxæ distant; fourth coxa very broad, in contact with the third throughout its whole length; palpi with the fourth joint very long, attenuate, slightly excavated towards the end to receive the fifth joint in a state of extreme flexion; fifth joint forming a pointed claw; mandibles consisting of a thick body cut off obliquely like the point of a pen posteriorly, truncate anteriorly, and terminated by a large, strong, and slightly curved claw; labium oval, concave and bifid.

Several species, of various brilliant colours.

A. histrionicus (*Hydrachna histrionica*, Herm.) (Pl. 2. fig. 14). Body dark red, paler in front of the eyes, a square black spot in front of them; dorsally marked with longitudinal converging striæ; five black spots on the anterior portion of the ventral surface; palpi and legs blackish green.

The black spots are produced by the viscera indistinctly visible through the skin.

Bibl. Walckenaer, *Aptères*, iii. (Gervais); Hermann, *Mém. Aptérol.*; Dugès, *Ann. d. Sc. Nat.* 2 sér. i.; Koch, *Deutschl. Crust.*, &c.

ATAXOPHRAGMIUM, Reuss. — The Buliminæ with arenaceous shells come under this denomination.

Bibl. Reuss, *Sitz. Ak. Wien.* xliv. 383.

ATHERO'MA.—Atheromatous deposits consist of globules of oil of the most varied sizes, frequently exceedingly minute, mixed with albuminous matter in the form of amorphous masses or flakes and molecules, plates of cholesterine and granules of carbonate of lime.

Bibl. Works on Medicine and Surgery; Lebert, *Phys. Pathol.*; Bennett, *Edinb. Monthly Journ.* vii.; Wedl, *Grundz. d. path. Hist.*; Rokitansky, *Ueber einig. d. wichtig. Krankh. d. Arterien.*

ATHY'RIUM, Roth.—A genus of Asplenieæ (Polypodioid Ferns). To this belongs the lady-fern, *A. Filix-fœmina*, formerly known as an *Aspidium* and a *Lastrœa*.

ATRAC'TIUM.—A supposed genus of Stilbacei (Hyphomycetous Fungi), characterized by its fusiform elongated spores, but now believed to be a state of some Nectria.

Bibl. Tulasne, *Carpologia*, iii. p. 104.

ATRACTOB'OLUS, Tode.—Described as a genus of Nidulariacei (Gasteromycetous Fungi), but now stated to be the egg of a *Raphignathus*.

ATRAC'TYLIS, Wright.—A genus of marine Polypes, of the order Hydroida, and family Atractylidæ.

Char. Polypes naked, borne on a stolon, erect, funnel-shaped, with a conical proboscis, surrounded by a simple whorl of filiform tentacles.

A. arenosa. Surface sanded. On stones, and roots of *Laminaria.*

Bibl. Hincks, *Hydr. Polypes*, p. 87.

AT'RICHUM, Palis.—A genus of Mosses, consisting of a subdivision of POLYTRICHUM.

BIBL. Wilson, *Bryol. Brit.* p. 202.

ATRO'PIA (Atropine). See ALKALOIDS, p. 30.

AT'ROPOS, Leach.—A genus of Hymenopterous Insects, of the family Psocidæ (Termitidæ).

Characterized by the long setaceous antennæ, which have more than ten joints, the absence of wings, the eyes of moderate size, and the three-jointed tarsi.

A. pulsatorius (book-mite) is very common in dried collections of plants, old books, &c., which form its food. It is about 1-20″ long, of a dirty-white or yellowish colour; head oblong; joints of antennæ elegantly striated transversely; mandibles horny and toothed; abdomen oblong-ovate, depressed; posterior femora thickened.

The allied genus *Psocus,* has the head broad, and the posterior margin of the fore wings with three or four cells. The species are found upon old palings, the bark of trees, &c.

BIBL. Westwood, *Entom. Text-book,* 368; id. *Introduct. &c.*, ii. 17 and 20.

AT'THEYA, West.—A genus of Diatomaceæ.

Char. Frustules compressed, annulate; valves elliptic lanceolate, with a median longitudinal line; angles spinous.

A. decora. Druridge Bay.

BIBL. *Micr. Trans.* viii. p. 152.

AULACODIS'CUS. See EUPODISCUS.

AULACOG'RAPHA, Leighton.—A genus of Graphideæ (Gymnocarpous Lichens), founded on the species *Aulacographa* (*Opegrapha*) *elegans,* Sm., distinguished by the peculiar furrows of the proper margins surrounding the disks of the lirellæ. Grows on the bark of trees.

BIBL. Leighton, *Ann. Nat. Hist.* 2nd ser. xiii. p. 389, pl. 7. 1854.

AULACOSI'RA. See MELOSIRA.

AULIS'CUS, Ehr.—A genus of fossil Diatomaceæ.

Differs from *Eupodiscus* in the processes being more solid and less fragile, and in the markings of the valves consisting of wavy festooned striæ, in some resolvable into dots, in others not. But the genus seems unnecessary.

Eupodiscus sculptus (Pl. 12. fig. 31) would form a species of *Auliscus.*

Auliscus pruinosus, Pl. 43. fig. 60.

BIBL. Ehrenberg, *Ber. d. Berl. Akad.*; Bailey, *Smithson. Contrib.* 1854; Greville, (*Monogr.*), *Micr. Trans.* 1863, p. 36; *ibid.* (*new spec.*), 1863, p. 75; 1864, pp. 82, 88; 1865, p. 5; 1866, p. 6; Rabenhorst, *Flor. Alg.* p. 320.

AULOCOM'NIUM, Schwægr.—A genus of Mosses. See MNIUM.

AURICULARI'NI.—A tribe of Hymenomycetous Fungi, characterized by having the inferior hymenium confluent with the pileus, and mostly even and free from papillæ or veins. See HYMENOMYCETES and BASIDIOSPORES.

AVAN'TURINE.—A mineral composed of silex, with numerous minute scales of mica interspersed through its substance, or traversed in all directions by minute fissures or cracks, giving it an elegant sparkling or iridescent appearance.

Artificial Avanturine consists of glass, with numerous minute crystals of metallic copper distributed through it. These crystals are mostly in the form of triangular or hexagonal plates, the angles sometimes curiously prolonged or beaked.

It forms a beautiful microscopic object.

It was originally manufactured at Venice, and the process kept secret. But MM. Fremy and Clémandot have shown that it may be prepared by heating glass with protoxide of copper and iron-scale (protoxide of iron); the latter reduces the protoxide of copper by combining with the oxygen so as to form the peroxide.

BIBL. Wöhler, *Chem. Gaz.* i.; Fremy and Clémandot, *l. c.* iv.

AVENEL'LA, Dalyell.—A genus of Infundibulate Polyzoa, of the suborder Cyclostomata, and family Vesiculariadæ.

Distinguished by the thread-like, nearly simple base; the large, scattered, solitary, slightly contracted and curved cells; and the 20 to 24 tentacles and small gizzard.

The single species, *A. Dalyellii* (*fusca*), brown, occurs matted with foreign matters; cells about 1-16″ long.

BIBL. Dalyell, *Remark. Anim. of Scotland,* ii. 65; Gosse, *Mar. Zool.* ii. 21.

AVICULA'RIA.—A term applied to the birds'-head processes of the Polyzoa. See POLYZOA.

AZOLLA, Kaulf.—A genus of Marsileaceæ or Rhizocarpeæ, consisting of a few species of small floating plants, occurring in Australia and throughout America. The mode of reproduction is evidently analogous to that of *Salvinia*; but its development has not yet been fully examined.

BIBL. R. Brown, *Flinders's Voyage*, ii. *App.* p. 611; Meyen, *Nova Acta Ac. C. L. N. C.* xviii. p. 507; Griffith, *Calcutta Journ. of N. Hist.* v. p. 227; Mettenius, *Linnæa*, xx. p. 259, 1847, transl. in *Ann. des. Sc. Nat.* 3 sér. xi. p. 111.

B.

BACILLA'RIA, Gmelin.—A genus of Diatomaceæ.

Char. Frustules bacilliform, at first united transversely into a straight tabular series, subsequently forming oblique series; valves with a longitudinal row of puncta, and an excentric keel; marine.

B. paradoxa (Pl. 12. fig. 14, and Pl. 43. fig. 17). Front view of frustules linear, rectangular, valves linear-lanceolate; length 1-220″. (*a*, front view of oblique series of frustules; *b*, valve.)

BIBL. Kütz. *Sp. Alg.* and *Bacill.*; Ehrenb. *Infus.*; Smith, *Brit. Diat.* ii. 8.

BACTERIAS'TRUM, Shadb.—A doubtful genus of marine Diatomaceæ, characterized by the compound cylindrical frustules, forming a filament, and the discoidal valves with radiate marginal slender rays.

B. curvatum (Pl. 43. fig. 18). Rays entire, arched; *B. furcatum*, rays straight, forked; *B. nodulosum*, rays simple, straight, covered with nodules; *B. Wallichii*, rays simple, straight.

BIBL. Shadbolt, *Qu. Micr. Journ.* ii. 14; Rabenhorst, *Flor. Alg.* p. 322; Lauder, *Mic. Trans.* 1864, p. 7.

BACTE'RIUM.—A supposed genus of Oscillatorieæ (Confervoid Algæ), consisting of extremely minute inflexible filaments, more or less distinctly jointed, from imperfect transverse division, often exhibiting a vacillating (not undulatory) movement. Ehrenberg and Dujardin place them among the infusorial animalcules (*Vibrionia*, Ehr. and Duj.); while Cohn regards *B. termo* as an active swarming brood produced by a Palmellaceous Alga (*Zooglœa*). The nature of these objects is very obscure.

1. *B. termo*, Duj., *Vibrio lineola*, Ehr. in part (Pl 3. fig. 17 *a*). Colourless, twice to five times as long as broad, slightly swollen in the middle, composed of one or two joints; length 1-9000 to 1-12,000″; breadth 1-12,000 to 1-50,000″. Placed by Ehrenberg with his *Vibrio lineola*, Ehr.

One of the earliest organisms appearing in decaying and putrefying animal and vegetable solutions; by some, supposed to cause the decomposition; and to form the microzymes of zymotic diseases.

2. *B. catenula*, Duj. (Pl. 3. fig. 17 *b*). Filiform, colourless, frequently three to five joints; total length 1-1250″; joints 1-7000 to 1-6000″ long, 1-60,000″ broad.

Probably only a degree of development of *Vibrio bacillus*.

3. *B. punctum*, Ehr. (Pl. 3. fig. 17 *c*). Ovoid-elongate, colourless, movement slow, vacillating, often in twos; length 1-5000″; breadth 1-10,000″.

4. *B. triloculare*, Ehr. (Pl. 3. fig. 17 *d*). Oval, two to five times as long as broad, with from three to six joints; length 1-2000 to 1-5000″; breadth 1-10,000″.

BIBL. Ehrenberg, *Infus.*; Dujardin, *Infus.*; Cohn, *Nova Act.* &c., 1854, xxiv. 101; *Qu. Mic. Journ.* iii. p. 206; Sanderson, *Privy Council Med. Rep.* 1870, p. 243; Lüders and Hensen, *Qu. Mic. Journ.* 1868, p. 32; Hoffmann, *Ann. d. Sc. Nat.* (*Bot.*), 1869, p. 5.

BACTRID'IUM, Kunze.—A genus of Torulacei (Coniomycetous Fungi); microscopic plants of tufted habit, growing upon decaying wood, old bark, &c.; white at first, but coloured subsequently by the condensation of the grumous contents of the spores. Three species are recorded as British:

Fig. 51.

Bactridium candidum. Magnified 200 diameters.

1. *B. flavum*, Kze. On elm stumps.

2. *B. Helvellæ*, B. and Br. On *Peziza testacea*.

3. *B. atrovirens*, B. On dead stumps.

BIBL. Berkeley, *Brit. Flora*, ii. pt. 2. p. 350; *Crypt. Bot.* p. 330; Kunze, *Mycol.* Heft i. pl. 1. fig. 2, pl. 2. figs. 20 and 21; Nees, *Nova Acta*, ix. pl. 1. fig. 3, pl. 2. fig. 21.

BADHA'MIA, Berk.—A genus of Myxogastres (Gasteromycetous Fungi), consisting of little variously coloured sacs growing in patches on decayed oak-branches, &c.; allied to *Physarum*, but remarkable for the spores, at first enclosed in a common sac, adhering in clusters. Filaments of the capillitium broad.

BIBL. Berk. *Linn. Trans.* xxi. 152. pl. 19; *Crypt. Botany*, p. 338.

BÆOMY'CES, Pers.—A genus of Lecidineæ (Gymnocarpous Lichens), growing on the ground or old walls, &c.

B. roseus, Pers. *Engl. Botany*, t. 374; Schærer, *Enum. Critic.* pl. 6. fig. 6.

BIBL. Hooker, *Brit. Flora*, ii. pt. 1. p. 141; Schærer, *Enum. Crit. Lich. Eur.* p. 182.

BAIRDIA, M'Coy.—A marine genus of Bivalved Entomostraca, belonging to the Ostracoda and related to the Cypridæ. First known by its valves alone, which are subtriangular. Abundant, both recent and fossil; and found even in the palæozoic rocks.

Bibl. M'Coy, *Carb. Foss. Ireland* (1844), 165; Jones, *Monog. Tert. Entom.* 51, and *Ann. N. H.* July 1868, 58; G. S. Brady, *Tr. Linn. Soc.* xxvi. 360 and 388.

BALANI'NUS, Germ.—A genus of Coleoptera, of the family Curculionidæ.

B. nucum is well known as depositing its eggs in nuts, upon which the larva lives, and from which it escapes, leaving a hole.

The beetle is 1-3″ long, with a rostrum nearly as long as the body. Larva white, with a brown head and strong jaws.

Bibl. Stephens, *Brit. Coleopt.* p. 232; Boisduval, *Entom. Hortic.* p. 152.

BALSAM (Canada). The liquid resin of the *Pinus Balsamea.* This is the ordinarily used and best medium for the preservation of dry transparent objects. The more colourless it is, the better. It should be kept in a wide-mouthed bottle, covered by a large cap, fitted by grinding. A piece of iron wire should be kept in the bottle, so that the desired quantity can be at once removed. It becomes thicker by keeping, but may be rendered thinner by mixture with oil of turpentine and digestion at a gentle heat. If too thin, it should be exposed to a gentle heat in a bottle covered with paper, to exclude dust.

See Preservation.

BALSA'MIA, Vittadini.—A genus of Tuberacei (Ascomycetous Fungi), characterized by the hollows which are lined by the fructifying cells not leading to the surface, and its cylindrical or oblongo-elliptic even sporidia.

Balsamia platyspora occurs in different parts of England, and is eagerly scratched up by the squirrels attracted by its strong scent.

Bibl. Tulasne, *Fungi Hypogæi*; Berk. *Outl.* p. 378.

BANA'NA. See Musa.

BANG'IA, Lyngb.—A genus of Porphyreæ (Florideous Algæ), placed among the Ulveæ by most authors, but stated by M. Thuret to be Florideous. Species marine, forming purplish, brownish-green, or red tufts of filaments, upon rocks and stones or on the fronds of other Algæ, from 1 to 4 inches long, or in *B. ciliaris*, only "half a line long." Harvey admits five, three of them, however, as doubtful:

1. *B. fusco-purpurea*, Dillw. Brownish green or purple glossy, several inches long; near highwater mark. *Phycol. Brit.* t. 96; *Brit. Algæ,* t. 25 C; *English Botany*, t. 2055 and 2085.

2. *B. ciliaris*, Carm. Forming a minute pink fringe on *Zostera marina.*

3. *B.? ceramicola*, Lyngbye. Purplish rose. On small Algæ; about 1″ long.

4. *B.? carnea*, Dillw. Pale red tufts on Confervæ.

5. *B.? elegans*, Chauv. Minute tufts 1‴ or 2‴ long, rose-red, parasitic on small Algæ, rare. Harv. *Phyc. Brit.* t. 246.

See Schizogonium.

Bibl. Harvey, *Brit. Mar. Algæ*, 2nd ed. 1849.

BAR'BULA, Hedw.—A genus of Pottiaceous Mosses, synonymous with *Tortula*, and including some of our commonest mosses, growing on walls &c.

Bibl. Wilson, *Bryol. Brit.* p. 134.

BARK.—The outer coat of the trunks and branches of Dicotyledonous shrubs and trees, succeeding to the epidermis as the young shoots become solid and woody. Bark is a complicated structure, composed of elementary tissues of various characters; and the great differences of appearance which it presents upon trees which have attained a certain age, result from the growth and multiplication of the elementary organs being subject to very different laws in different plants. Bark is the collective term applied to the entire cortical mass outside the cambium region of the stem (see Cambium). It contains three distinct regions or forms of structure; and in young branches the epidermis, still remaining on the outside, constitutes a fourth.

If we examine a young shoot of the Maple (*Acer campestre*) while still green, by making transverse and perpendicular radial sections, we find the surface to be covered by an epidermis composed of small cells, closely conjoined at their sides. Under this occur six or eight strata of thin-walled, colourless cells, which stand vertically over one another, and when mature are elongated in the radial direction of the branch. These form the *cork-substance, suberous layer*, or *phlœum.* Beneath or within these, we find a layer composed of parenchymatous cells, filled with chlorophyll granules, forming the *cellular envelope* or *parenchymatous layer*; this is continuous within with the external part

of the medullary rays. Interposed between the cellular envelope and the *cambium* region occur the liber-bundles (see LIBER), forming the *fibrous layer* of the bark. In the bark of the Maple the corky substance grows very fast at first, and soon splits the epidermis above it, but after a certain number of years its growth slackens, so that it seldom acquires very great thickness, especially as it is very soft and readily rubbed off; the cellular layer does not grow fast, merely keeping pace with the enlargement of the stem which it surrounds. The layers of liber increase year by year so as to form a very distinct fibrous layer.

In the Cork-Oak (*Quercus Suber*), the bark of which, when young, does not differ much from that of the Maple, the cellular layer grows most in the earlier years, and the epidermis is not destroyed until the third, fourth, or fifth; then the cork-substance begins to increase in an important degree, by the multiplication of its cells at the inner side, bordering on the cellular envelope. New layers of cork-cells are produced successively, expanding much in the radial direction. They are thin-walled and destitute of contents, of squarish form (Pl. 38. figs. 16 & 17) and soon become dry. The outer layers being unable to expand sufficiently to allow the enlargement of the stem, tear irregularly and give the surface of the stem a rough and cracked aspect. On old stems we observe that the formation of these layers has not been continuous, but in successive groups or sets, which causes the appearance of a darker and more solid structure, composed of tabular cells, at the points where successive sets of layers adjoin, just as is the case at the lines of union of the annual rings of wood in Dicotyledonous stems. But these lines are here very irregular. The cellular envelope takes no share in the formation of the cork of this tree.

In the Birch (*Betula alba*), there is a very decided distinction between the layers of the cork-substance, namely between the large thin-walled colourless cells and the denser tabular cells forming the dark streaks in the cork. The epidermis is succeeded here by a *periderm* composed of tabular cells with brown contents, corresponding to the darker parts of common cork; in stems of 20 years' growth, the bark presents as many as fifty lamellæ of this substance, which lamellæ are separated from each other by layers of the lax white cork-cells. The readiness with which the latter structure gives way causes the lamellæ to peel off in thin scales; and these bring away a portion of the white intermediate structure on both faces, and thus acquire their peculiar silvery aspect.

In the Beech (*Fagus sylvatica*), where the bark is smooth, even on old trees, the growth takes place chiefly in the liber-layers, and the cellular envelope and cork-substance merely expand to make room for the enlargement of the stem; the cork-substance is here a *periderm*, i. e. composed of the flat tabular cells, not loose cork tissue. The Holly, Ivy and other smooth-barked trees are analogous to this.

The scaling off of the bark of the Plane (*Platanus occidentalis*) arises from the formation of layers of tabular peridermal cells between the layers of liber; the bark outside the layers dries and falls away by the tearing of this peridermal layer. Here, therefore, the periderm is produced from the cellular envelope.

In the Lime (*Tilia*), the Oak (*Q. Robur*) and other trees, a similar production of peridermal layers within the liber takes place; but the layers remain *in situ* for a long time, and fall away irregularly, often persisting for a considerable number of years as rugged, many-layered scales.

In many of the Coniferæ (such as the Scotch Fir and Larch), the peridermal structure is in like manner developed from the cellular envelope; here, however, the cells are not tabular, but parenchymatous, and multiply and enlarge so as to form a thick layer of cork-like tissue, which loses all relation with the medullary rays. The turpentine-canals and liber fibres, engaged in this corky periderm, become disturbed and displaced by its irregular growth.

In some plants, such as the Vine, the Honeysuckle, &c., the bark is always stringy, which arises from the formation of each annual layer of liber being followed immediately by the drying-up, and soon by the destruction, of the layers of the preceding year, so that no proper periderm of suberous or cellular layers exists here after the first year. The same takes place in the third or fourth year in the *Clematis*.

The inner layers of the bark are especially distinguished by the presence of laticiferous canals in those plants in which that tissue exists; these are said by Schacht to be in many cases a modification of the liber tissue. Further particulars are given on this head under LIBER, where also the intimate struc-

ture of the *liber* will be explained. See also LENTICELS and CORK.

BIBL. *Text-Books on Structural Botany*: Henfrey, *Elem. Course* (Masters); Mohl, *Entwick. des Korkes*, &c., *Vermischt. Schrift.* 1845, p. 212; Hanstein, *Ueber d. Bau &c. der Baumrinde*, Berlin, 1853; Schacht, *Die Pflanzenzelle*, p. 237 *et seq.* 1852.

BARLEY.—One of the important cereal grains, furnished by the *Hordeum sativum* and its varieties (Monocot. Plants, N. O. Gramineaceæ). The starch of the albumen of the seeds has a form somewhat resembling that of wheat, but it may be distinguished under the microscope (Pl. 37. fig. 9); and the small starch-grains are more numerous and smaller than in wheat or rye, and most of them are in active molecular motion when immersed in water. (See STARCH.) Pearl-barley is obtained by a peculiar mode of grinding, by which the outer coat or shell of the grain is removed.

BARTRA'MIA, Hedw.—A genus of Bartramiaceous Mosses, containing several common species. *B. pomiformis*, with its apple-like capsules, is common on dry sandy banks.

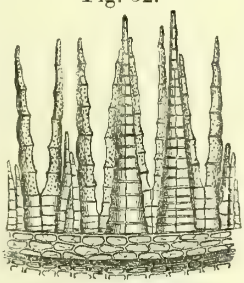
BIBL. Wilson, *Bryol. Brit.* p. 277.

BARTRAMIA'CEÆ.—A tribe of Bartramioideæ (operculate Apocarpous Mosses) containing several genera. British genera:

I. *Conostomum.* Calyptra dimidiate. Peristome simple; teeth sixteen, lanceolate, equidistant; *erect when wet or dry*, densely and nodosely tuberculated, with a median line, connate in pairs at their apices, and coherent into an oblique closed cone.

II. *Bartramia.* Calyptra dimidiate. Peristome either absent, simple or double. External, of sixteen lanceolate, smooth, tuberculate teeth, with a median line or sometimes separating in the middle, *erect when wetted, incurved when dry*, red. Internal: a membrane with sixteen folds, produced into sixteen lanceolate, keeled, broad teeth, ultimately split into two divergent articulated lobes, with one to three cilia interposed or none (fig. 52).

Fig. 52.



Bartramia marchica.
Magnified fragment of peristome.

III. *Catascopium.* Calyptra hood-shaped, smallish. Peristome simple; teeth sixteen, lanceolate, very short, truncate-lanceolate, differing in form, unequal, transversely articulated, with a median line, whitish, rugulose, rigid and suberect. Capsule inclined on the collum, globose, small, discelioid, shining-brown, and ultimately growing black, thick-skinned, almost horny, without an annulus, smooth.

BARTRAMID'ULA, Br. and Sch. (*Bartramia*, Müller).—A genus of Mosses separated from *Bartramia* by some authors on account of the smooth capsule and absence of a peristome.

BIBL. Wilson, *Bryol. Brit.* p. 276.

BARTRAMIOI'DEÆ. — A family of operculated Acrocarpous Mosses, of cæspitose habit and varying size. Leaves very varied in form, erect or reflexed, with terete nerves; cells parenchymatous, and, except in certain species, furnished with solitary papillæ on the transverse walls on both faces, mostly square or more or less hexagonal; lax or loosish, and densely filled with chlorophyll, or with a persistent primordial utricle, rarely thickened. Capsule with a long neck, funarioid, pear-shaped or spherical, regular or asymmetrical, straight or variously inclined, smooth or grooved, with an operculum mostly hemispherical or conical, rarely beaked. This family is divided into two tribes:

1. MEESIACEÆ. Areolation of the leaf lax, smooth, often destitute of primordial utricle (*Meesia*), or lax and densely papillose (*Paludella*). Capsule erect, elongated, with a more or less elongated neck, hence *more or less pear-shaped*, smooth, the *neck bearing stomata.*

2. BARTRAMIACEÆ. Areolation either lax and smooth, lax and papillose, dense and smooth, or dense and papillose. Capsule erect or inclined, horizontal or pendulous, regular or asymmetrical, smooth or grooved, *but more or less spherical, devoid of stomata.*

BARYTA.—A knowledge of the crystalline forms of the salts of baryta is sometimes useful in determining the presence of this substance.

Butyrate of baryta (Pl. 6. fig. 23). When rapidly separating from an aqueous solution, it forms a pearly film upon the surface; this consists of dense aggregations of very transparent crystalline laminæ, not perfectly separable from each other (*a*). When more slowly formed, stellate groups of crystals are produced (*b*). The individual crystals are rarely perfect; and some are so thin and

transparent that their outlines are scarcely distinguishable.

Hydrofluosilicate of baryta (Pl. 6. fig. 24). Its production is a test for the presence of baryta. The crystals are scarcely affected by either nitric or muriatic acid.

Sulphate of baryta (Pl. 6. fig. 25). When rapidly formed, consists of crystalline granules (*a*). When more slowly precipitated from dilute solutions, it consists of very minute stellate foliaceous crystals, somewhat resembling those of the ammonio-phosphate of magnesia (*b*). See STRONTIA and LIME.

BIBL. See CHEMISTRY.

BASEMENT MEMBRANE, of Animals.—Is a very thin, transparent, elastic and structureless membrane, lying between the cutis and epidermis of the skin, and between the epithelium and submucous tissue of the mucous membranes and their prolongations. It is of considerable firmness, and serves to support the layer or layers of epidermal or epithelial cells. It is not always easily separable and demonstrable, but is perhaps most readily so in the urinary tubules of the kidneys.

In chemical composition, this membrane mostly resembles elastic and not areolar tissue.

BASID'IA. See BASIDIOSPORES.

BASID'IOSPORES.—The name applied to the acrogenous spores produced in groups, mostly of a definite number, more frequently of four, on the hymenium of many Fungi, the term *basidium* (sporophore, Berk.) being applied to the four-branched cell upon which they are attached. Basidiospores are produced both by the Hymenomycetous and Gasteromycetous Fungi. In the former they are found upon the external fruit-bearing surfaces, such as the gills or vertical plates of Agarics, on the walls of the tubes of *Polyporus*, &c. In the Gasteromycetes

Fig. 53.

Development of the basidiospores of Hymenangium griseum.

they are produced upon the convoluted hymenium which occupies the interior of the Fungus in the earlier stages of growth; and when the spores are mature, the hymenium and the basidia becoming dissolved, the spores fall loose in the cavity. The basidiospores sprout out gradually from the basidia,

Fig. 54.

Basidia and basidiospores of Melanogaster variegatus.

Fig. 55.

Basidia and basidiospores of Octaviana asterosperma.

Magnified 400 diameters.

becoming soon shut off by a cross septum, and in some cases they finally acquire a dense and dark-coloured outer coat.

BIBL. Berkeley, *Ann. Nat. Hist.* i. 81. pl. 4 and 5, iv. 155. pl. 5; Léveillé, *Ann. des Sc. Nat.* 2 sér. viii. 321. pl. 8–11; Tulasne, *Fungi Hypogæi*, passim.

BAST or BASS. See LIBER.

BATARRE'A, Pers.—A singular genus of Trichogastres (Gasteromycetous Fungi), characterized by a universal gelatinous volva, and a hat-shaped receptacle seated on the top of a tall stem.

B. phalloides is occasionally found in England, but only in a very few localities, either in sand or in the dusty residue in the inside of hollow trees.

BIBL. *Sow.* t. 390; Berk. *Out.* p. 299.

BATHYBIUS. — A protoplasmic body, in small or large masses, without investing membrane or test, found among abyssal ooze.

BIBL. Huxley, *Brit. Assoc. Rep.* 1868; *Qu. Micr. Journ.* 1868, p. 210.

BATRACHOSPER'MEÆ.—A family of Confervoid (?) Algæ. Brownish-green or purplish freshwater plants; filamentous, coated with gelatine. The fronds composed of aggregated longitudinal filaments, bearing at intervals whorls of short, horizontal, cylindrical or beaded, jointed ramuli. Diœcious. Fructification: ovate spores attached to the lateral ramuli, which consist of minute dichotomous filaments. British genera:

1. *Batrachospermum.* Lateral whorled ramuli beaded; spores collected in globular knobs in the whorls.

2. *Thorea.* Stems continuous, whorled,

articulated, sometimes branched, ramuli cylindrical, the spores at their bases.

BIBL. See these genera.

BATRACHOSPER'MUM, Roth.—A genus of Batrachospermeæ (Confervoid Algæ), regarded by Thuret and A. Braun as probably referable to Florideæ, consisting of delicate, branched, filamentous plants of green, yellow, red, or purple colour, growing in clear slowly running fresh water. The branched axes of the plants of *Batrachospermum* (fig. 56) consist of rows of large cylindrical cells applied end to end, and increase in length by the successive trans-

Fig. 56.

Fig. 57.

Fig. 59.

Fig. 58.

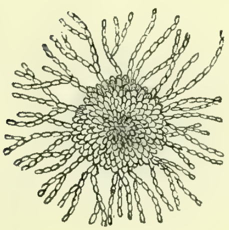


Fig. 56. Batrachospermum moniliforme. Natural size.
Fig. 57. A portion of an axis with whorls of branches. Magnified.
Fig. 58. A tuft of branches with spores in the midst. More magnified.
Fig. 59. Highly magnified view of a few cells of an axis with nascent radiating ramules and their descending cortical cells.

verse cell-division of the terminal dome-shaped cell. While the cells or joints of the axes are still young, they send off a number of radiating processes, which soon become cut off by septa, so as to constitute distinct cells, and then elongate and ramify so as to form the whorls of articulated ramules (fig. 59), which at length become very dense (fig. 57). From the basal cells of these branches secondary branches grow down perpendicularly over the cell of the main axis immediately below (fig. 59), forming at length a kind of rind over it. This differs from the analogous structure in *Chara*, in the fact that there branches grow up as well as down from each articulation of the axis, and meet halfway. Some of the ramules which grow out free become fertile, and produce spores at their extremities, while others grow out into transparent capillary points.

The spores are produced in large numbers in each tuft, forming an agglomerated heap (fig. 58) at each articulation. The branches of the main axis are produced by lateral budding of its cells, just above and as it were in the axils of the smaller whorled brenches. Braun has found specimens of *B. cærulescens* and *B. Suevorum* destitute of the glomerules of spores, but with smaller hyaline (Antheridial) cells at the ends of the branches, as in NEMALEON.

According to Bornet and Thuret, trichogynes exist. These consist of a basal cell (ultimately the cystocarp), communicating by a narrow neck with the upper portion, which is not capillary, but expands into an oval cell, to which the antheridia adhere. These are few, rounded, and arise from the summit of certain peripheral branches; and contain fertilizing globules.

The specimens frequently change colour when dried upon paper, becoming usually much darker. Bory St. Vincent carefully examined the distinctive characters of this genus; and he is followed by Hassall, who, however, erects several of his varieties into species. The following forms are given under Kützing's arrangement:—

1. *B. moniliforme*, Roth. Vaguely and greatly branched, colour various (purple, violet, green, æruginous, fuscescent or nigrescent); whorls or nodes moniliform, distinct, globose, those of the branches confluent. Dillwyn, Tab. ii.; Kütz. *Tab. Phyc.* iii. pl. 22. The following species of Hassall are considered to be varieties of this: *pulcherrimum, stagnale, rubrum.*

2. *B. giganteum*, Desv. Very large, purple when dry, axes clothed with very long bifurcated branches. Kütz. *Tab. Phyc.* iii. pl. 23. *B. confusum*, Hass.

3. *B. affine*, Kütz. *Tab. Phyc.* iii. p. 24.

4. *B. cærulescens*, Bory. Æruginous, slender, very much branched, branches flagelliform, equal, slender, slightly thickened at the tips, whorls of the lower and upper branches confluent, those of the intermediate distinct, contiguous, depressed. Kütz. *Tab. Phyc.* iii. pl. 24.

5. *B. vagum*, Ag. Æruginous, dichotomously branched, equally thick throughout, whorls all confluent. Kütz. *Tab. Phyc.* iii. pl. 25; var. *tenuissimum* = *Conf. atra*, *Eng. Bot.* pl. 690.

B. bambusinum, Bory, and *B. helmintosum*, Bory (Tab. 29), have not been seen by Kützing.

Rabenhorst admits two species, *B. moniliforme*, with nine, and *B. vagum*, with five varieties.

Bibl. Bory St. Vincent, *Ann. du Muséum*, xii. 188, 316 *et seq.* pl. 22, 29; Hassall, *Freshw. Algæ*, p. 101 *et seq.* pl. 13–16, 63; Decaisne, *Ann. des Sc. Nat.* 2 sér. xvii. p. 340, pl. 15, i.; Braun, *Verjüngung*, p. 160 (*Ray Soc.* 1853, p. 150); *Alg. Unicell.* Appendix, p. 105; Kützing, *Spec. Alg.* p. 535, *Tab. Phycol.* iii; Rabenhorst, *Flor. Alg.* iii. p. 404; Bornet and Thuret, *Ann. d. Sc. Nat.* 1867, vii. p. 144.

BDELLA, Latr.—A genus of Arachnida, of the order Acarina, and family Bdellea.

Char. Those of the family (see Arachnida). Species numerous.

1. *B. longicornis* (*vulgaris*) (Pl. 2. fig. 31 *a*, *b*, mandible). Scarlet; rostrum longer than the front segment of the body; eyes 4; length 1-24''.

2. *B. cærulipes* (Pl. 2. fig. 31 *c*, mandible). Rostrum tolerably short and stout; mandibles thick and obtuse; eyes 4; body reddish; legs blue.

3. *B. elaphus* (Pl. 2. fig. 41). Rostrum inflated at base; carmine red, with iridescent shades; eyes 2, blackish; a long bristle on each side.

Bibl. Gervais, Walckenaer's *Apts.* p. 154; Koch, *Deutschl. Crust.* and *Myr.*; Dugès, *Ann. d. Sc. Nat.* i. 21.

BDELLEA.—A family of Arachnīda, of the order Acarina.

The members are minute, more or less soft, variously coloured, and live in damp places beneath moss, upon the sand of caves, &c. Palpi attached to the sides of the rostrum, as antennæ in the Curculionidæ. Movements slow. The single genus,

Bdella, has the characters of the family, and includes the genera *Scirus*, Dug. and *Amonia*, Koch.

Bibl. Gervais, Walckenaer's *Apts.* p. 154; Koch, *Deutschl. Crust. Myr.* &c.

BEAN-FLOUR. See Flour.

BEANIA, Johnst.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Scrupiadæ.

Distinguished by the creeping adherent branched thread, upon which the sessile erect scattered cells are placed, each with a double spinous keel on one side.

B. mirabilis. Parasitical on shells and rocks at or within low water-mark, or creeping among the roots of *Bugula* (*Cellularia*, Johnst.) *avicularia.* Cells 1-24'' long.

Bibl. Johnston, *Brit. Zooph.* x. 371; Gosse, *Mar. Zool.* ii. 14; Busk, *Catalogue*, &c. (Brit. Mus.)

BEE. See Apis.

BEER.—The fermentation by which this liquid is produced results from the growth of the yeast-plant, a microscopic Fungus. See Yeast and Fermentation.

When ammonia is added to beer, a precipitate of the ammonio-phosphate of magnesia falls, resembling that subsiding from urine under the same circumstances (Pl. 9. fig. 3). This, in the sugar-beer as now made, is almost absent; and the beer is deprived of an important element of nutrition.

BEGGIATOA, Trevis.—A genus of Oscillatoriaceæ (subgenus of *Oscillatoria*, Kütz.), distinguished by the free, rigid, sheathless fibres, enveloped in mucus, and the white granular endochromes. Four species: found in warm mineral springs.

Bibl. Rabenhorst, *Flor. Alg.* ii. p. 94.

BELBA, Heyden (*Damæus*, Koch).—A genus of Arachnida, of the order Acarina and family Oribatea.

Char. Abdomen separate from the thorax, rounded as if bulbous; legs long, geniculate.

The species live on moss, under stones, &c.

Bibl. Walcken. *Aptères*, iii. (Gervais), p. 256; Koch, *Uebers. d. Arachnid. Systems.*

BENZOIC ACID. — This acid is well known as occurring naturally in benzoin resin and some other resins. It is found in animal secretions (urine) only as a product of the decomposition of hippuric acid. It is also a product of the oxidation of proteine compounds. It is but slightly soluble in cold, more readily in hot water and in alcohol, also in ether.

Its crystals belong to the right-rhombic prismatic system. It is readily sublimed; and the crystals thus produced form shining delicate needles. When crystallized from a solution, it usually forms dendritically arranged superimposed plates with angles of 90°, sometimes narrow six-sided needles or prisms; occasionally the angles are truncated, so that the inclination of the edges amounts to an angle of 135°.

It is not unfrequently obtained from urine

when not fresh, in attempts to procure hippuric acid. It may be distinguished from hippuric acid by its much greater solubility in ether, by its crystallization in the plates, and their form (Pl. 7. fig. 13).

BERGMEHL.—The German expression for mountain-flour. A powdery or more or less coherent mineral, consisting principally of the siliceous valves of the Diatomaceæ. In some countries it is mixed with articles of food in times of scarcity. See DIATOMACEÆ.

BERKELEY'A, Greville.—A genus of Diatomaceæ (Cohort Naviculeæ).

Distinguished by the navicular frustules being immersed in the branches of the gelatinous frond, which is rounded at the base.

The valves are exceedingly thin, brittle and transparent. No markings have been detected upon them; but there can scarcely be a question that they exist.

B. fragilis (Pl. 14. fig. 8). Filiform branches mostly simple, crowded; valves lanceolate, obtuse; length 1-330″. British.

Branches about 1–4″ in length. Found upon marine plants and rocks.

B. adriatica. Branches lax, subdivided, attenuate and flagelliform; valves narrowly lanceolate, almost linear, somewhat obtuse; length 1-200″.

BIBL. Grev. *Scot. Crypt. Flora*, tab. 294; Ralfs, *Ann. Nat. Hist.* 1845, xvi. p. 110; Kützing, *Bacill.*, and *Sp. Alg.*; Smith, *Brit. Diat.* ii. 67.

BET'ULA, L.—The Birch-tree (Dicotyledonous Plants, N. O. Betulaceæ), remarkable for its peculiar silvery periderm. See BARK. The bark of *B. nigra* contains reservoirs filled with an aromatic oil and also a peculiar resin, called Birch Camphor, which is used in the manufacture of Russia leather.

BEYRICH'IA, M'Coy.—An extinct genus, belonging probably to the Ostracoda, very abundant throughout the palæozoic rocks, and presenting a great variety in their small oblong and deeply lobed valves. Thirty-nine species are recorded from the Silurian, two from the Devonian, and seven from the Carboniferous rocks.

BIBL. Jones, *Ann. N. H.* 1855, 81 & 163; *Month. Mic. Journ.* 1870, 191.

BIBLAR'IUM, Ehr.—A genus of fossil Diatomaceæ.

Distinguished from *Tetracyclus* by the frustules being single, which difference probably depends upon the species only having been found by Ehrenberg in the fossil state.

Twelve species (Pls. 41. fig. 39; 43. figs. 35–48). Fossil in Siberia and Oregon.

BIBL. Ehrenberg, *Ber. d. Berl. Akad.* 1844–45, and *Ann. Nat. Hist.* 1848, 393; Kützing, *Sp. Alg.*; Smith, *Brit. Diat.* ii. 37.

BICELLA'RIA, De Bl.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Bicellariadæ.

B. ciliata (*Cellularia ciliata*, Johnst.) (Pl. 33. fig. 5 *a* and 5 *b*). The only British species; is parasitical upon Algæ, Polypi, &c. within low-water mark.

An elegant microscopic object.

BIBL. See BICELLARIADÆ.

BICELLARIADÆ (*Cellularia*, Johnst. in part).—A family of Infundibulate Polyzoa, of the suborder Cheilostomata.

Distinguished by the erect plant-like polypidom being dichotomously divided into narrow ligulate branches in two or more rows; the absence of whips (vibracula); and the avicularia when present being stalked and jointed. Genera (British):

1. *Bicellaria.* Cells top-shaped, distinct, armed with spines; orifice looking upwards.
2. *Bugula.* Cells elliptical, closely contiguous; orifice very large; margin simple, not thickened (avicularia frequently red or blue).

BIBL. Johnston, *Brit. Zooph.*; Busk, *Catalogue*, &c. (Brit. Mus.)

BICHRO'MATE OF POTASH. See POTASH.

BIDDULPH'IA, Gray.—A genus of Diatomaceæ.

Char. Frustules compressed, quadrilateral, connected with each other by the angles; filament attached by a stipes; angles of the frustules equal and produced; valves covered with depressions (visible by direct light), giving them a cellular appearance; centre of valves with spines; marine.

This genus resembles *Isthmia* and *Amphitetras* in the general appearance of the frustules and valves. But it differs from the former in the angles being alike, and from the latter in the compressed side view of the frustules. Frustules often with rounded transverse elevations, between which are costæ or shallow vittæ. Those in which the angles are more prolonged and acute, and the markings indistinct, are retained by Kützing in the genus *Odontella*, Ag. (*Denticella*, Ehr. in part).

1. *B. pulchella*, Ehr. (*B. tri-, quinque-*, and *septem-locularis*, Kütz.) (Pl. 12. fig. 15). Costæ 3–7, central one with two or three short spines; produced angles rounded; markings coarse; length 1-400 to 1-200″.
2. *B. aurita*, Bréb. (Pl. 14. fig. 9). Markings

indistinct; costæ none; angles horn-like; spines two or three, central; length 1-800″.

3. *B. rhombus*, Smith (*Zygoceros rh.* Ehr.?) (Pl. 14. fig. 13, Ehr.; Pl. 41. fig. 16, Smith). Markings indistinct; costæ none; spines near the hoop; angles horn-like; length 1-60 to 1-260″.

4. *B. Baileyi*, Sm. Markings indistinct; costæ none; angles horn-like; sides of frustules with two slight elevations, each with one or two long spines; length 1-250″.

5. *B. turgida* (*Cerataulus turgidus*, Ehr.). Markings faint; costæ none; angles cylindrical, truncate; frustules with a row of short and two large submedian spines on each side; length 1-240″.

6. *B. regina.* Sides of frustules each with three rounded median elevations; spines none; angles rounded, with distinct markings; length 1-220″.

Several other species, but not British.

Bibl. Kützing, *Bacill.* and *Sp. Alg.*; Ehrenb. *Ber. d. Berl. Akad.* 1843 & 1844; Ralfs, *Ann. Nat. Hist.* 1843, xii. 273; Smith, *Brit. Diat.* ii. 47; Greville, *Micr. Trans.* 1864, pp. 9, 85; 1865, pp. 6, 19, 49; 1866, pp. 6, 81; Rabenhorst, *Flor. Alg.* i. p. 310; Pritchard, *Infus.* p. 847.

BIFORI′NES.—Under this name Turpin described certain cells occurring in the septa of the air-chambers of the leaves of the Araceæ, characterized especially by the presence of a large bundle of raphides. They contain a thick fluid; and when they are placed in water, endosmose causes them to burst and discharge the crystals. Turpin's long account of them contains much useless disquisition and various errors. See Raphides.

Bibl. Turpin, *Ann. des Sc. Nat.* 2 sér. vi. p. 5. pl. 1–5.

BIGENERI′NA, D'Orb.—One of the numerous modifications of the Textularian type; instead of continuing to form bilateral alternate (Enallostegian) chambers, it advances in growth with a straight single (Stichostegian) series; and the aperture becomes central, terminal, and rounded, instead of being a transverse arch low down on the septal face. If the aperture be excentric, we have the *Gemmulina* of D'Orbigny. *B. agglutinans* (Pl. 18. fig. 50) is an elongate and coarse-shelled variety of *B. nodosaria.* Common in many seas, and in the fossil state.

Bibl. D'Orbigny, *For. Foss. Vien.* 237; Carpenter, *Introd. For.* 191.

BIGNONIACEÆ, (Dicotyledonous Plants).—The wings of the seeds of this family afford very beautiful objects. They are either thin membranes composed of a layer of lignified cells; or, as in the Catalpas, the wing consists of a fringe of hairs.

BILE.—Three colouring-matters have been obtained from the bile, viz. cholepyrrhine, biliverdine and bilifulvine. These were formerly regarded as distinct; but later researches have tended to show that they are modifications of the same pigment.

Cholepyrrhine, the colouring-matter in its ordinary state, is characterized by the series of tints through which it passes when treated with nitric acid, especially if this contain nitrous acid; becoming first brownish, then green, bluish, violet, red, and finally yellow. It is sometimes found in bile in the form of yellow semicrystalline grains; at others it enters into the composition of biliary calculi.

Bilifulvine is also sometimes found in bile which has been retained in the gall-bladder. The bile then appears thick and dark brown, and exhibits small dark grains. Under the microscope, the crystals of bilifulvine are found in these grains. They form longish, very fine needles, of a reddish-yellow colour, either single or several combined. When the needles are aggregated, they sometimes resemble the crystals of urate of soda, having a thick globular extremity and a fine point, and they are often variously curved and twisted. Caustic potash dissolves them tolerably readily. When the solution is neutralized and acidified, no precipitate or separation of crystals occurs. Acetic acid produces no change in them. Nitric acid has but little effect upon them, unless the action is very intense, when they are decomposed. Virchow suggests that bilifulvine holds an intermediate place between hæmatoidine and melanine, and notices the occurrence of these crystals upon the walls of the cysts of *Echinococci* in the liver, where we have also found them, and in the liquid contents of the cysts. In this instance, two kinds of crystals were met with (Pl. 9. fig. 15); some of these were rhombs (*a*), others were twisted and elegantly curved bundles of needles (*b*). When first examined, they were yellowish-red; but after remaining a day or two in the liquid of the cysts, they became almost perfectly yellow. When mounted in balsam, the rhombs remained unaltered, whilst the long filamentous groups of needles lost all colour, leaving a barely distinguishable transparent skeleton. Both kinds were insoluble in acetic acid, but soluble in potash with a yellow colour.

In morbid bile, crystals of cholesterine, globules of fat, and small bundles of needles of margarine are also occasionally found.

See HÆMATOIDINE.

BIBL. Lehmann, *Gmelin's Handbuch d. Chem.* viii.; Virchow, *Annal. d. Pharm.* &c. 1851 (*Chem. Gaz.* x.); Griffith, *Pract. Man. on the Blood*, &c.; Karsten, *De hep. et bile Crustac. et Mollusc.*; Frey, *Histol.* &c. 1870, p.504; Städeler, *Poggendorff's Annal.* cxxxii. p. 323.

BILIFULVINE. See BILE.

BILIRUBINE.—A red colouring-matter, allied to Hæmatine and Hæmatoidine; occurring in the bile and gall-stones. It is insoluble in water, but soluble in benzole, bisulphuret of carbon, and chloroform; from which it crystallizes in splendid ruby-red crystals, somewhat resembling in form the natural crystals of uric acid. It exhibits the play of colours with nitric acid.

BIBL. That of BILE.

BILOCULI'NA, D'Orb.—One of the Milioline Foraminifera, in which each successive segment embraces more or less completely the preceding segments, on alternate sides, so that only two chambers of the shell are visible externally. It varies much in form and size; the varieties are very common, recent and fossil, and have numerous names: the largest has been found at 650 fathoms in the North Atlantic (*Carpenter*). *B. ringens* (Pl. 18. fig. 3) is taken as the type.

BIBL. D'Orbigny, *For. Foss. Vien.* 261; Williamson, *Brit. Foram.* 78; Carpenter, *Introd. Foram.* 75, 78.

BIME'RIA, T. S. Wright.—A genus of Hydroid Polypes, of the family Atractylidæ. The body and lower part of the tentacles are enveloped by an opaque brown membrane.

B. vestita. Attached to zoophytes and sea-weeds.

BIBL. Hincks, *Hydroid Zoophytes*, p. 103.

BINOCULAR MICROSCOPE.—This has been alluded to at p. xii of the Introduction. We have no space for the figures requisite to illustrate descriptions of the three principal forms of binocular microscope; hence we must be satisfied with referring to the works in which they will be found.

If the binocular microscope were perfect, undoubtedly it would be more pleasant to use both eyes in viewing an object; although little inconvenience results from the ordinary single-eyed vision. But in the examination of new structures, no reliance should be placed upon the appearances presented by them under binocular vision, unless controlled by the means pointed out in the second part of the Introduction.

The three forms of binocular construction are those of Wenham, Holmes, and Stephenson.

BIBL. Wenham, *Micr. Trans.* 1860, p. 154; 1861, p. 15; 1866, p. 103; *Qu. Micr. Journ.* 1861, p. 109; Holmes, *Month. Micr. Journ.* 1869, iii. p. 274; Stephenson, *Month. Micr. Journ.* 1870, iv. p. 61; Frey, *D. Mikr.* 1868; Carpenter, *The Microsc.* 1868.

BIS'PORA, Corda.—A genus of Torulacei (Coniomycetous Fungi), characterized by its uniseptate spores forming simple and solitary bead-like chains at the apices of short, slender, erect filaments, destitute of septa, arising from a creeping mycelium. It was separated from *Torula* by Corda on account of the double character of the spores. According to Fresenius, the chains of spores are pedicellate as above described, and the growth of the chains appears to take place by division of the terminal cell or spore.

Fig. 60.

Bispora monilioides. Magnified 200 diam.

B. monilioides, Corda, of which fig. 60 represents the chains of spores without the pedicels, is British (*Torula*, Auct.). On sticks.

BIBL. Corda, *Icones Fungorum*, vol. i. pl. 2. fig. 143; Fresenius, *Beitr. zur Mycologie*, Heft 2. p. 57, pl. 6. figs. 46–54; Greville, t. 255.

BITARTRATE OF POTASH. See POTASH.

BLASIA, Micheli.—A genus of Pellieæ (Hepaticæ). The British species, *B. pusilla*, L., occurs on moist heaths, not uncommonly in the mountainous parts of England, Scotland, and Ireland. In addition to the antheridia and pistillidia, and the sporanges developed from the latter, this plant produces *gemmæ* of two kinds. One kind are formed in receptacles hollowed out of the nerve, furnished with a long tubular beak, whence the gemmæ escape when mature. The second kind are described as black spherical masses of granular or pulpy substance, and occur within the epidermis on the under side of the frond, often covered by the scales.

BIBL. Hooker, *Brit. Jungermanniæ*, t. 82–84; *Eng. Botany*, t. 1328; *Brit. Flora*, ii. part 1. 130.

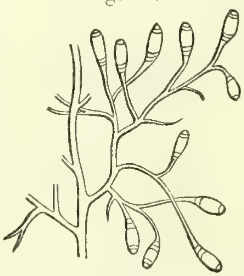
BLASTOTRICHUM,—Corda.—A sup-

posed genus of Dematiei (Hyphomycetous Fungi), of curious habit, growing in and out of water upon aquatic plants. *B. confervoides*, Corda (fig. 61), forms felted tufts of an agreeable rose-colour upon living and dead parts of aquatic *Euphorbiæ*, in autumn. The filaments are very much branched, the branchlets dichotomous and subulate; the spores rose-coloured, containing a gelatinous nucleus within. The spores are irregularly divided, and some remain imperfect; but both these and the perfectly septate reproduce the plant when sown. The form occurring above the surface of the water is of closer habit than the submerged, in which the filaments are longer and more lax.

Berkeley is of opinion that this plant is only a state of some *Dactylium*, perhaps *D.* (Tricothecium) *roseum*.

Bibl. Corda, *Icones Fung.* ii. p. 10, pl. 9. fig. 50; Berkeley, *Crypt. Botany*, p. 302.

Fig. 61.



Blastotrichum confervoides.
Fragment of fertile filament.
Magnified 200 diameters.

BLAT'TA.—A genus of Orthopterous Insects, of the family Blattidæ.

Blatta orienta'lis is the common house black-beetle or cockroach. The head and the various organs of the mouth are figured in Pl. 26. fig. 1, the upper and front view; fig. 2 the under view; fig. 22 the parts of the mouth separate.

Head oval, and concealed beneath the large plate of the protothorax. *Antennæ* (fig. 1 *a*, broken off) very long, setaceous, pubescent, and with very numerous joints; they are inserted close to the inner margins of the eyes; basal joint stout and subovate, second and third squarish, larger than any of the following, which are ring-shaped towards the base of the antennæ, become square (in the side view) at the middle, and oblong at the apex. *Labrum* (fig. 1 *e*, fig. 22, lower part of *a*) exserted, entire, roundish, truncated at the base. *Mandibles* (fig. 22 *b*) short, stout, toothed at the tip and on the inner margin; basal portion of the inner margin membranous, forming a little lobe. *Maxillæ* (figs. 1 & 2 *g*, 22 *c*) bilobed; inner lobe (lacinia, fig. 22 *c*†) dilated and ciliated on the inner margin, acute, curved inwards at the apex so as to form a tooth; outer lobe (galea, fig. 22 *c**) longer, thick, rounded and naked; maxillary palpi (figs. 1 & 2 *h*) elongated, rough with short hairs, 4-jointed, the last joint somewhat hatchet-shaped. *Labium* (fig. 22 *e*) elongated, bifid, with two more slender inner lobes; labial palpi (fig. 2 *k*) pubescent, 3-jointed, last joint truncated obliquely. *Mentum* (fig. 2 *l*) short, convex at the base. Eyes (fig. 1 *c*) kidney-shaped.

Thorax semicircular, the base convex; elytra coriaceous, one overlapping the other and with numerous nerves. Wings large, folded longitudinally, with numerous nerves. Females apterous. Abdomen flat, oval, and terminated by two short, conical, compressed, jointed appendages in both sexes; besides which, in the male, there are two slender, external, not-jointed appendages or styles, also an elongated intermediate one. Legs long and compressed; coxæ elongated and stout; femora stout with a series of spines beneath; tibiæ clothed with very strong moveable spines; tarsi 5-jointed, three basal joints gradually diminishing in length; claws curved and acute.

See Insects.

Bibl. Westwood, *Introd. &c.*; Kirby, *Brit. Entom.* i. 12.

BLECH'NUM, Linn.—A genus of Ferns. *Bl. Spicant*, With., is the Hard Fern, also called sometimes *Bl. boreale*, but properly Lomaria *Spicant*.

BLIGHT.—This word is used in common language in an exceedingly loose and undefined way, being applied to almost every cause of disease in plants, as well as to the diseases themselves, which are variously explained by agencies of meteorological conditions, parasitic plants and insects, operating singly or in combination. Blight is, indeed, 'in the air' in many cases, since a frequent source of disease in vegetation is sudden change of temperature or hygroscopic condition of the atmosphere, deranging the processes of evaporation and respiration in the tender, actively developing portions of the foliage or inflorescence of plants. It is also often 'in the air' in another sense, but much less specially than is commonly supposed: the plagues of parasitic fungi and insects which sometimes cause such devastation, seem undoubtedly to arise immediately from the transport of the microscopic reproductive bodies, spores and the like, through the air; but the pe-

culiar atmospheric conditions often observed as accompanying the sudden irruption of large masses of such 'blights,' are only collaterally connected with the development of these bodies; the warm overcast weather, almost proverbially designated as the cause or the herald of blights, is merely an index of a condition of the atmosphere especially favourable to the rapid multiplication of the Fungi and Insecta which are seen to increase so rapidly at such times; and the germs of these must be already present, through other causes, for the production of the phenomena under such circumstances.

Only a few of the animal blights need be referred to here, such as the plant-lice, the most familiar form of 'blight' in cultivated plants (see APHIDES), the 'pepper-corn' or 'ear-cockle' of wheat (see EAR-COCKLE and ANGUILLULA), the wheat-midge (see CECIDOMYIA), the turnip-fly (see HALTICA), and the species of *Cynips* and allied genera which produce galls and similar excrescences by the irritation of the vegetable tissue, resulting from their presence.

Many caterpillars of moths and butterflies are exceedingly destructive, and form a kind of blight, but these scarcely come within our province.

The vegetable blights, the parasitic Fungi growing upon living specimens of the higher plants, and displaying themselves either as the cause or the accompaniment of some disease and disorganization, have of late years become objects of most earnest attention, on account both of the enormous damage which the diseases have caused to crops of plants of high importance to man, and also of the many curious facts in their history which have been brought to light. The Potato blight and the Vine disease of recent years have incited renewed efforts to elucidate the history of these productions, as yet, however, imperfectly made out. The old notion, that these products were the result of skin-diseases or exanthemata of plants, is now pretty generally discarded, especially as many of them have been grown artificially from their spores.

The general history of the conditions of their occurrence, and a summary of the investigations into their history, is given under the head of PARASITIC FUNGI. The particular history of the more remarkable genera will be found under the heads indicated by the capitals in the following paragraphs.

Corn-blights consist chiefly of *mildew* (PUCCINIA), *rust* or *red-robin* (UREDO, TRICHOBASIS), *smut, bunt* or *brand* (TILLETIA, USTILAGO, POLYCYSTIS), *ergot* (CORDICEPS), &c. CYSTOPUS (*Uredo*) attacks Cruciferous plants. *Mildews* of pease, peaches, hops and many other cultivated plants are produced by species of ERYSIPHE. OIDIUM is a common mildew, and is known in many cases to be only an earlier condition of *Erysiphe*. BOTRYTIS is another common mildew. ÆCIDIUM forms a kind of *rust*, as is the case with the allied RŒSTELIA, infecting pear-trees. See also UROMYCES, POLYCYSTIS, COLEOSPORIUM, PROTOMYCES, EPITEA, PHRAGMIDIUM, FUSISPORIUM, TORULA, PERIDERMIUM, SCLEROTIUM, SPILOCÆA, SPHÆRIA.

BIBL. De Bary, *Unters. üb. die Brandpilze*, Berlin, 1853, chap. 3. p. 102; Berkeley, *Trans. Hort. Society, Gardener's Chronicle*, passim; A. Braun, *Krankheiten der Pflanzen*, Berlin, 1854 (transl. *Quart. Journ. of Microsc. Science*, July 1854); Sidney, *Blights of the Wheat*, Rel. Tract Society; article *Blight*, in *Brande's Dictionary, the Penny Cyclopædia, and the Library of Entertaining Knowledge*; Boisduval, *Entom. Horticole.*

BLINDIA, Br. and Sch.—A genus of Dicranaceous Mosses, including some *Weissiæ* and *Gymnostoma* of authors.

BIBL. Wilson, *Bryol. Brit.* p. 57.

BLOOD.—This animal fluid, with the general appearance of which in the higher animals every one is so familiar, is no less difficult in its microscopic study, than it is complex in its chemical composition. In man and mammalia, birds, reptiles and fishes, it is a viscid liquid of a red colour. In those of the lower classes in which it exists, it is mostly colourless, sometimes, however, red, bluish, purplish, greenish or milky.

When examined under the microscope the blood is found to consist of a liquid portion, containing in suspension a large number of minute corpuscles, which are known commonly as the globules or corpuscles of the blood.

In the Mammalia, Birds, Reptiles, and Fishes generally, the liquid portion, or *liquor sanguinis* as it is called, is nearly colourless, or of a pale yellow tinge; and the corpuscles are of two kinds, one of a red colour when viewed in mass, but pale reddish yellow when seen singly or separately; and to these the red colour of the blood is owing; the others consist of perfectly colourless bodies.

The *red corpuscles* are far more numerous than the colourless ones, about 500 to 1, and

consist of delicate membranous colourless cells enclosing a red liquid. In the Mammalia they assume the form of circular flattened disks or discoidal cells, the sides of which are depressed or hollowed out, so as to make them resemble doubly concave lenses, with rounded margins (Pl. 40. figs. 21, 22 & 23); in the Camel tribe, however, they are elliptical and doubly convex. In Birds (figs. 24 & 25), Fishes (figs. 26 & 27), and Reptiles (figs. 28, 29 & 30), they are elliptical and flattened, the form of the sides varying: thus, in Birds and Fishes they are convex, excepting the Cyclostomes or lamprey family among the latter, in which they are circular, flattened and slightly concave, only differing from those of man in being somewhat larger; and in one genus of this family, *Amphioxus lanceolatus* (the lancelet), there are no blood-corpuscles. In the Reptiles, in which they are elliptical, very large, and comparatively thin, the surfaces of the corpuscles are rather concave than convex, the nucleus projecting somewhat laterally.

The red corpuscles of the Mammalia are not furnished with a nucleus, whilst in Birds, Fishes, and Reptiles a distinct nucleus exists; this is usually oval, but sometimes rounded in the latter.

The *colourless corpuscles* of the Vertebrata (figs. 21–30*b*), or the lymph-corpuscles as they are sometimes called, are spherical, of a granular appearance, highly refractive and specifically lighter than the coloured corpuscles. They consist of a cell-wall containing numerous larger or smaller granules and molecules, with one or more nuclei. Acetic acid dissolves the granules, and brings the nuclei to view. The cell-wall is often undistinguishable, unless water be added to the corpuscles, which being imbibed, separates it from the contents. When blood is kept at a moderate heat, these corpuscles exhibit various *Amœba*-like processes, crawl over the slide, and even take up particles of foreign substances, as vermilion, carmine, &c.

The blood of the Invertebrata has not been so thoroughly examined. In many of them there are two circulating liquids—one coloured, but containing no corpuscles, the other colourless and containing rounded or irregular granular colourless nucleated corpuscles (figs. 31–35), much resembling the colourless corpuscles of the Vertebrata, but remarkably prone to shoot out processes like the Amœbæ.

The sizes of the *coloured* corpuscles of many vertebrate animals are given in the subjoined list, nearly all the measurements being those by Gulliver. It may be remarked that, whilst the largest coloured corpuscles occur in the Reptiles, the smallest are found in the Mammalia, and that the size of the corpuscles is in general proportional to the size of the animal, in animals of the same order, but not in those of different orders. Thus in the larger Ruminants and Rodents the corpuscles are larger than in the smaller ones, whilst the smallest British mammal, the Harvest-mouse, has corpuscles as large as those of the Horse; and in the common mouse they are larger than in the Horse or Ox.

Mammalia.

Bimana. Man, 1-3200 to 1-3500″.

Quadrumana. Chimpanzee (*Simia Troglodytes*), 1-3412; Monkey (*Cercopithecus mona*), 1-3468; Monkey, mean of eight other species, 1-3450; Lemur, mean of four species, 1-4077.

Cheiroptera. Bat (*Vespertilio murinus*), 1-4175; Bat (*Vespertilio pipistrellus*), 1-4324.

Insectivora. Hedgehog (*Erinaceus europæus*), 1-4085; Mole (*Talpa europæa*), 1-4747.

Carnivora. Badger (*Meles vulgaris*), 1-3940; Bear, mean of five species, 1-3708; Dog (*Canis familiaris*), 1-3542; Fox (*Canis Vulpes*), 1-4117; Lion (*Felis Leo*), 1-4322; Seal (*Phoca vitulina*), 1-3281.

Cetacea. Dolphin (*Delphinus Phocæna*), 1-3829; Whale (*Balæna Mysticetus*), 1-4000; Whale (*Balæna Boops*), 1-3099.

Pachydermata. Elephant (*Elephas indicus*), 1-2745; Horse (*Equus caballus*), 1-4706; Pig (*Sus Scrofa*), 1-4230; *Rhinoceros indicus*, 1-3765.

Ruminantia. Camel (*Camelus bactrianus*), length 1-3123; breadth 1-5876; Dromedary (*Camelus dromedarius*), l. 1-3254, b. 1-5921; Goat (*Capra hircus*), 1-6366; Musk (*Moschus javanicus*), 1-12325; Stag (*Cervus elaphus*), 1-4324; Ox (*Bos Taurus*), 1-4267; Sheep (*Ovis Aries*), 1-5300.

Edentata. Armadillo (*Dasypus sex-cinctus*), 1-3457; Sloth (Unau, *Bradypus didactylus*), 1-2865.

Rodentia. Guineapig (*Cavia cobaya*), 1-3538; Mouse (*Mus musculus*), 1-3814; Rabbit (*Lepus cuniculus*), 1-3607; Rat (*Mus Rattus*), 1-3754.

Marsupialia. Kangaroo (*Macropus*), mean of three species, 1-3460.

Monotremata. Platypus, duck-billed (*Ornithorhynchus paradoxus*), 1-3000.

Birds. Chaffinch (*Fringilla cœlebs*), length 1-2253, breadth 1-4133; Cuckoo (*Cuculus canorus*), l. 1-2028, b. 1-3600; Eagle (*Aquila*), mean of four species, l. 1-1640, b. 1-3651; Fowl (*Gallus domesticus*), l. 1-2102, b. 1-3466; Gull (Mew-, *Larus canus*), l. 1-1973, b. 1-3839; Humming-bird (*Trochilus* —— ?), l. 1-2666; b. 1-4000; Ostrich (*Struthio camelus*), l. 1-1649, b. 1-3000; Owl (*Strix flammea*), l. 1-1882, b. 1-3740; Parrot (*Psittacus*), mean of twelve species, l. 1-2042, b. 1-3724; Pigeon (*Columba*), mean of sixteen species, l. 1-2135, b. 1-3679; Sparrow (*Fringilla domestica*), l. 1-2140, b. 1-3500.

Reptiles. Crocodile (*Crocodilus acutus*), l. 1-1231, b. 1-2286; Frog (*Rana temporaria*), l. 1-1108, b. 1-1821; Lizard (*Lacerta vivipara*), l. 1-1660; *Siren lacertina*, l. 1-435, b. 1-800; Toad (*Bufo vulgaris*), l. 1-1043, b. 1-2000; Triton (*Lissotriton punctatus*), l. 1-830.

Fishes. Carp (*Cyprinus carpio*), l. 1-2142, b. 1-3429; Eel (*Anguilla vulgaris*), l. 1-1745, b. 1-2842; Jack (*Esox lucius*), l. 1-2000, b. 1-3555; Miller's Thumb (*Cottus gobio*), l. 1-2000, b. 1-2900; Perch (*Perca fluviatilis*), l. 1-2099, b. 1-2824; Tench (*Cyprinus Tinca*), l. 1-2286, b. 1-2722.

The colourless corpuscles have not been so extensively examined. They do not vary so much in size in different animals as is the case with the coloured corpuscles. Those of the human blood are about 1-2500″ in diameter.

The red corpuscles of blood are readily altered in form by most liquids; those of less specific gravity than the liquor sanguinis distend them, rendering them larger, paler and more transparent, and effacing the lenticular appearance and the elliptical form when present. If the liquid be added in large proportion, the envelope or cell-membrane becomes extremely thin and pale, until at last it is no longer distinguishable; sometimes it bursts. These phenomena are the result of endosmosis. The red corpuscles, however, are not all equally acted upon: some are much more affected than others; some even appear almost entirely to resist the action of endosmotic agents, and are found but little altered, even when the blood is mixed with a large proportion of water. They then subside to the bottom of the vessel. This has given rise to the erroneous notion that water at first renders the red corpuscles larger and then diminishes their size. Although water and other endosmotic agents distend the coloured corpuscles, and render their envelopes so extremely transparent that they can no longer be recognized, yet many of them may be restored to view by the addition of reagents which either act exosmotically, colour them, or render them opaque; as solution of iodine, of bichloride of mercury, and various other salts. We shall see presently that, during their earlier stages of development, the coloured corpuscles are many times as large as in their mature condition. Dilute acids act nearly in the same manner as water, but much more rapidly. Dilute solutions of alkalies produce the same effect, but soon dissolve them completely. Solutions of neutral salts act exosmotically, rendering them smaller, more flattened, and producing wrinkles, folds, or a granular appearance in the enveloping membrane. Frequently also they appear covered with little points, giving them an elegant stellate aspect. This stellate or crenate appearance is not unfrequently seen immediately that frêsh blood is examined under the microscope. Two principal conditions are especially favourable to its production, viz. a concentrated state of the liquid, and an increase in the proportion of alkaline chlorides.

The corpuscles of the blood of the hepatic vein are smaller, more spherical, without the central depression, and resist the action of water for a longer time than the ordinary corpuscles; similar corpuscles are also met with in the spleen. These are by some regarded as young newly formed corpuscles; while those of the portal vein possess the ordinary characters.

Matters which coagulate the albuminous matter of the red corpuscles, such as alcohol, tannic acid, and creosote, also heat, alter their form; giving rise to the production of tail-like processes, with adherent minute globules, which also cover the surface of the corpuscles. And by pressure the latter are broken up into a number of similar globules.

The colourless corpuscles are much less affected by reagents. Water distends them slightly, rendering their granulations less distinct. Acetic acid does the same to a greater extent, bringing to light the nuclei. Alkalies dissolve them. When blood is mixed with a large quantity of water, the mixture shaken and set aside, a pale buff precipitate subsides; this consists of some of the albu-

men thrown down from the serum, with shreds and walls of ruptured coloured corpuscles, a few of the latter unaltered, and some unaltered or but slightly changed colourless corpuscles.

Almost immediately after the blood of the Vertebrata has left the blood-vessels, it begins to coagulate. Within about three minutes, the surface of the coagulating blood becomes gelatinous; in about ten minutes it is gelatinous throughout; and after a further lapse of time, the coagulation of the fibrine apparently attains its maximum: this process, however, is not really completed until from twelve to thirty-six hours. We then find a firm red clot immersed in a yellowish liquid. The fibrine during its coagulation entangles a large number of the corpuscles, which impart to it the red colour; this is greatest towards the lower part of the clot. The liquid from which the clot has separated, the serum, also contains some of the globules in suspension; most of those not entangled in the clot, however, subside to the bottom of the vessel. The sp. gr. of the serum is about 1030. The appearances presented under the microscope by a drop of coagulating blood are very interesting. If examined immediately after removal from the body, the corpuscles are seen to be diffused irregularly over the field; but after the lapse of about a minute, the red corpuscles unite by their broad surfaces, gradually arranging themselves into rows resembling strings of figs: these interlace, forming an irregular red network, within the meshes of which the colourless corpuscles are seen (Pl. 40. fig. 37). The latter remain isolated, having no tendency to unite with the former. To observe these phenomena, the thin glass covering the drop of blood must not be pressed down, otherwise the free motion of the corpuscles will be impeded. After a time, the fibres break up, and the corpuscles float separately in the serum.

The coagulated fibrine is also seen distributed over the field, partly in a granular form, but mostly in that of a network of very delicate fibres. Sometimes the running together of the red corpuscles begins to take place immediately the blood has left the body, and the rows are seen to be formed very much more rapidly than in the healthy fluid; and when this is the case, the upper surface of the clot will be found to be free from the red colour, and more or less cupped or concave: this upper layer is called the buffy coat, and is in general a sign of inflammation. Considerable doubt still exists in regard to the nature of this buffy coat. It is also met with in blood which has been covered with a layer of oil before coagulation. But in the natural state it arises from the subsidence of the corpuscles before the commencement of the solidification of the fibrine, whereby the particles of the latter are brought into closer contact, thus allowing of its greater contraction. Certain salts prevent the separation of the fibrine in the form of fibres, and cause it to assume the form of minute granules or globules. (See FIBRINE.)

In addition to the corpuscles above described which are constantly found in the blood, it sometimes contains globules of oil, and, after meals especially, two distinct kinds of a white, extremely fine, molecular substance,—one consisting of fat, the molecular base of the chyle, the other a very finely divided albuminous substance. They render the blood milky in appearance. The distinction of the molecular base of the chyle from the molecular albuminous deposit must be effected by ether, which dissolves the latter but not the former; but great care is requisite in judging of the action of ether.

The colour of the blood of the Vertebrata varies according to whether it is removed from the arteries or the veins, in the former case being of a much lighter and brighter red than in the latter. It is beyond our province to enter into the details of the causes of their difference; suffice it to say, that it arises principally from an alteration in the globules, by which they are enabled to reflect light more copiously.

In the Invertebrata the coagulation of the blood is imperfect, and the clot much less firm and copious than in the Vertebrata.

The uses of the blood scarcely require mention. It is at the same time the nutritive fluid from which all the tissues of the body are formed and renovated, and that in which the components of the secretions are produced and from which they are separated. The red particles are subservient to the purposes of respiration; they are most numerous in those animals in which the respiratory function is most active, and which consume the largest proportion of oxygen, as birds and mammalia.

Development of the Coloured Corpuscles.— In the Vertebrata, two sets of coloured corpuscles are developed. The first, or embry-

onic blood-corpuscles, exist alone, until lymph and chyle begin to be formed, when they are gradually superseded by the second.

The first blood-corpuscles are formed from colourless nucleated cells with granular contents, identical with the formative cells of the embryo, by their losing the granules and becoming filled with hæmatine. These coloured, nucleated, primary blood-cells, which are spherical, larger and more deeply coloured than the coloured blood-corpuscles of the adult, form, with the colourless formative cells, the only elements of the blood. Soon, however, many of them begin to increase by division (Pl. 40. fig. 36), becoming elliptical and flattened, and closely resembling the coloured corpuscles of Reptiles, producing two, rarely three or four roundish nuclei, and then becoming resolved into two, three, or four new cells by the formation of one or more annular constrictions. These corpuscles then gradually lose their nuclei, become flattened and excavated laterally, and form perfect coloured corpuscles.

The formation of the second set, or those produced after birth and in adults, is more obscure. The most probable view appears to be that they are produced from the lymph and chyle-corpuscles, or certain corpuscles in the spleen, by their losing their nuclei, becoming flattened, and producing hæmatine. At all events, corpuscles apparently identical with the so-called proper corpuscles of the chyle, surrounded with a membrane which is more or less distended with a red liquid, are met with in the chyle and lymph, and occasionally, but rarely, in the blood itself. Physiologists are not agreed as to the above views; but the preponderance of evidence appears decidedly in their favour. Recklinghausen has directly observed the conversion of the colourless corpuscles of the frog into the coloured corpuscles.

As unusual constituents of blood, may be mentioned:—

1. Cells enclosing coloured blood-corpuscles; found in the blood of the spleen, liver, &c.

2. Granule-cells, either colourless or containing granules of pigment.

3. Peculiar concentric bodies, three or four times as large as the coloured corpuscles of the blood, resembling those found in the thymus gland.

4. An unusually large number of colourless corpuscles.

5. Pus-corpuscles.

6. Caudate cells, sometimes containing pigment.

7. Crystals of hæmatoidine, sometimes within the coloured corpuscles, at others free; also crystals of hæmatine and hæmatoglobuline (hæmoglobine).

8. The two molecular substances previously mentioned.

It sometimes becomes of importance to be enabled to determine the presence of blood in supposed blood-spots, &c., and to distinguish that of man from that of animals. As regards the former point, it is a matter of no great difficulty. When blood has been dried at ordinary temperatures, the dried serum and contents of the corpuscles redissolve on digestion with cold water; and this is the condition under which the blood is generally presented for examination in such cases. We then have the fibrine left undissolved, which may be tested as to its chemical and microscopical characters (Fibrine). The liquid is decolorized by boiling, and the coagulum assumes a brown colour (Hæmatine). It also contains iron, is unaltered in colour by solution of potash, and contains a proteine compound (Proteine). In heating very minute quantities upon a glass slide, the fluid must always be covered with a slip of thin glass, to prevent its drying. The mere presence of blood can thus be chemically determined without much difficulty; for these reactions may be observed under the microscope in a very minute quantity; but the distinction of small quantities of the blood of man from that of animals by chemical means, is impossible. We have therefore only the morphology of the elements to decide from. The portions of blood presented for examination will be almost invariably in a dried state; and the red corpuscles, when dried in a very thin layer, retain so nearly their natural size and outline, that any kinds of blood which are distinguishable in the fresh state, are certainly so when dried; but it will seldom happen that the blood will be dried upon a transparent substance, and in thin layers, permitting of its examination by transmitted light. We have then to separate it from some fabric or structure, and restore as nearly as possible its original appearance. This can be done by digesting the blood in a saturated solution of bichloride of mercury, which has a remarkably slight action upon the corpuscles, allowing both their natural form and size to be judged of with great accuracy; and by digesting the blood in a cold

solution of this salt, and placing it under a bell-glass for some hours, the red corpuscles may be detached with a camel's-hair pencil, and examined. Of course, only those corpuscles should be measured which evidently retain their natural form. The red corpuscles of the mammalia are readily distinguishable from those of the lower classes in the animal kingdom by their circular discoidal form and the absence of a nucleus; but those of individual species can only be recognized by a difference in size.

Virchow recommends that the blood-spots be mixed with dried and powdered chloride of sodium; next, that glacial acetic acid be added, and the mixture evaporated at 212°, when the blood-crystals are abundantly deposited. This method is said to succeed when ordinary tests fail.

The spectroscope must not be forgotten in this investigation.

We should recommend those who are likely to undertake such investigations to make their own table of sizes; for it curiously happens that in general the size of the same objects given by different observers varies considerably. This arises probably from using too low a power, want of practice, and the use of a false standard. And we should not advise any one to attempt to form a judgment in a question of this kind except he be thoroughly acquainted with the use of the microscope and micrometric investigations, and has made numerous experiments upon this special point.

The corpuscles of the blood are best studied while existing in the serum of that liquid; but the white of egg neutralized with acetic acid exerts but little action upon them, as is also the case with a solution of bichloride of mercury. The colourless corpuscles are most easily recognized when the blood has been mixed with water.

They are best preserved when dried in a very thin layer upon a slide—a drop of blood being placed upon the slide, and the latter placed in a perpendicular position, so that a very thin layer will remain.

BIBL. Paget, *Brit. and For. Med. Rev.* xiv. p. 260; Kölliker, *Hand. d. Gewebel.* p. 567; the Manuals on Physiology, by Müller, Valentine, Wagner, Carpenter, and Kirkes; the Dictionaries of Todd and Bowman, and Wagner; Hassall, *Microscop. Anat.*; Vogt, *Ann. d. Sc. Nat.* 3 sér. ii.; Gulliver, *Gerber's Anat.*; *Ann. Nat. Hist.* xvii.; *Proc. Zool. Soc.* 1862, p. 91; Schmidt, *die Diagnostik verdächtiger Flecke*, &c. 1848; Frey, *Histologie*, p. 109, and the copious BIBL. therein; Browning (*Spectroscope*), *Month. Micr. Journ.* ii. p. 116; Rollett, *Stricker's Handb.* i. p. 574.

BLOOD ON BREAD.—Bread, flour, paste, and similar substances are sometimes attacked by a fermentation-fungus, which produces patches of a blood-red (or sometimes of an amber) colour. Most authors attribute the plants to the genus (?) *Oidium*, or to forms of *Penicillium*. Ehrenberg observed only minute corpuscles, which he called *Monas prodigiosa*. We have found these patches on sour paste, of red and yellow colour, consisting of isolated oval cells not more than 1-3000″ in diameter, and they were associated with *Penicillium glaucum*. of which they are probably a conidial form; this form is called *Cryptococcus glutinis* by Fresenius, who thinks it distinct from the so-called *Monas prodigiosa* of Ehrenberg, which he found in the form of corpuscles about 1-24000 to 1-48000″ in diameter. Montagne regards the plant as a *Palmella* (*prodigiosa*); and Mr. H. O. Stephens is of the same opinion.

This substance sometimes occurs on decaying Fungi. The blood-rain on damp wall-paper, calico, and old gourds and melons, is the mycelium of a species of *Epicoccum*.

BIBL. Ehrenb., Fresenius, *Beit. z. Mycologie*, Heft ii. p. 78; Desnon, *Mém. de la Soc. des Sc. Nat. de Cherbourg*, iv. p. 19; Montagne, *Compt. Rend.* 1852; *Ann. Nat. Hist.* 2 ser. x. p. 309; Berkeley, *Crypt. Bot.* p. 264; Stephens, *Ann. Nat. Hist.* 1853, xii. p. 409, pl. 17.

BLOOD-VESSELS. See VESSELS.

BLOOD-WORM.—The larva of *Chironomus plumosus*.

BLOXAMIA, Berk. and Br.—A genus of Sphæronemei (?) (Coniomycetous Fungi), consisting of minute punctiform sacs, soon bursting above, containing closely packed tubes producing each a row of squarish spores. An anomalous genus, allied to *Cystotrichia* and *Myxormia*. *B. truncata* has been found on dead Wych elms.

BIBL. Berk. and Broome, *Ann. N. Hist.* 2 ser. xiii. 468, pl. 16. fig. 17; Berk. *Crypt. Botany*, p. 329.

BLYTTIA, Endlich.—A genus of Pelliеæ (Hepaticæ) founded on the *Jungermannia Lyellii* of Hooker, remarkable for the double envelope of the fruit, the outer being very short, dentate and laciniated, while the inner forms a largish, somewhat plaited

cylinder. The antheridia arising from the rib are covered by incumbent scales, which are sometimes much laciniated and crowded together, sometimes (*J. hibernica*, Hook. *Brit. Jungerm.*) scarcely toothed, lax and larger.

Fig. 62.

Blyttia Lyellii, magn. 2 diam.

Bibl. Hooker, *Brit. Jung.* t. 77 & t. 78; Nees, *Lebermoose*, iii. 313; *Flora Danica*, t. 2004.

BO'DO, Ehr.—A genus of Infusoria, belonging to the family Monadina. (Monads with a tail.)

Char. A tail; no eye-spot present; mouth terminal; animals sometimes united in the form of a mulberry or a bunch of grapes.

Ehrenberg describes eight species.

Some of them inhabit the intestinal canal of the frog. One is green, the rest are colourless.

Dujardin regards one species (*Bodo grandis*) as comprising both his *Heteromita ovata* and a species of *Anisonema*; the others he considers imperfectly examined species belonging to his genera *Cercomonas* and *Amphimonas.*

Bodo grandis, E. (*Heteromita ovata*, D.). Aquatic; length 1-940 to 1-720'' (Pl. 23. fig. 18*a*).

Bodo socialis, E. (Pl. 23. fig. 18, *b*, *c*). Aquatic; length 1-3000''.

Bibl. Ehrenberg, *Infus.*; Dujardin, *Infus.*; Pritchard, *Infus.*

BŒHME'RIA, Jacq.—A genus of Urticaceous plants closely allied to our common Stinging Nettle, and characterized, like that and other species of *Urtica*, by containing tenacious liber-fibres. Two species are employed in the East Indies on this account. *B. nivea*, Gaudichaud, yielding the fibre from which Chinese grass-cloth (Pl. 21. fig. 25) is manufactured, is a native of China, where it is largely cultivated, also in Sumatra, where it is called Caboose, and at Pulo Penang, where it is called Rami. *B. Puya*, Wallich, yields the Pooah or Puya fibre of Nepaul and Sikkim (Pl. 21. fig. 26), which has long been extensively used in India, and is said to equal the best European flax when properly dressed; being ordinarily roughly prepared, it is dirty and bad-coloured, but makes excellent sail-cloth and cordage.

Bibl. Hooker, *Journal of Botany*, vols. i. & iii. 1849-51.

BOLACOT'RICHA, Berk. & Broome.—A genus of Mucedines (Hyphomycetous Fungi), containing one species, *B. grisea*, found growing upon dead cabbage-stalks, old mats made of *Typha*, &c., in tufts forming large, effused, grey patches. Messrs. Berkeley and Broome express themselves doubtfully as to its real affinities; in habit it approaches *Myxotrichum*, but differs in its simple threads and large spores, while the spores are not in chains as in *Sporodum*, or minute and linear as in *Tricholechonium*. The threads are pale purple under the microscope, strongly curved at the tips like tendrils.

Bibl. Berkeley and Broome, *Ann. Nat. Hist.* ser. 2. vii. p. 97, pl. 5. fig. 4.

BOLE'TUS, Dill.—A genus of Polyporei (Hymenomycetous Fungi), consisting of pileate Fungi, or 'toad-stools,' often of large size, growing in woods. They have the basidia contained in tubes arranged perpendicularly to the pileus and opening at its lower surface; the transverse sections of the tubular hymenium thus exhibit circular holes separated by double septa, each pore being formed by a perfect tube, while in *Polyporus* the septa are single, from the tubes being undistinguishably blended. Several of the species (which are numerous) are esculent, especially *B. edulis*, which, when in perfection, is one of the best of Fungi; many, on the other hand, have the reputation of being poisonous, and undoubtedly are so at times, though Sir W. C. Trevelyan assures us that he has eaten *B. luridus* with impunity. The late Mr. Salter, when attached to the Geological Survey, almost lived on some of the species which grow on mountains, being at a distance from places where he could readily obtain other food. See Basidiospores.

BOLIVI'NA, D'Orb.—A subdivision of the Bulimine Foraminifera, in which the peculiar infolded notch-like aperture is retained; but the chambers grow bilaterally alternate (Enallostegian), instead of triserial and obliquely spiral (Helicostegian), as in *Bulimina* proper. The shell is delicate and porous. *B. punctata* and *B. costata* are the two leading forms. Varieties are common in all seas, and date from the Cretaceous period.

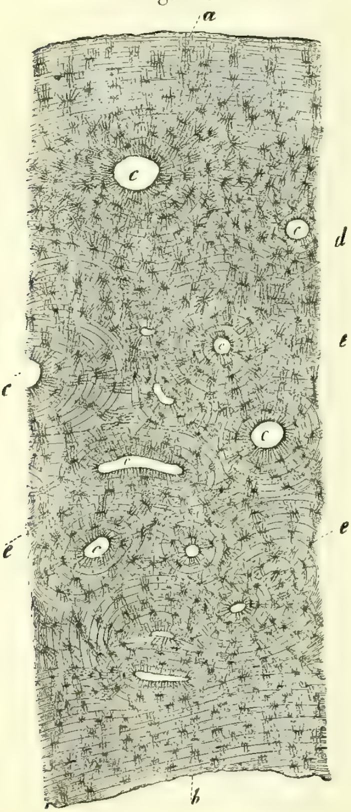
Bibl. D'Orbigny, *For. Foss. Vien.* 239; Carpenter, *Introd. For.* 196.

BOMBA'CEÆ.—A subdivision of the family of Dicotyledonous plants called Stercu-

liaceæ, some genera of which are called Silk-cotton trees, from the long hairs which envelope their seeds, as in the true cotton plants. These hairs (from *Chorisia speciosa*, *Bombax*, sp. var., *Eriodendron*, sp. var.) cannot be spun, but are used for stuffing cushions, &c. The *Adansonia*, or Baobab-tree, produces a pulpy fruit, which contains a considerable proportion of starch. The wood of some kinds, as of *Bombax pentandra* and *Pachyra* (*Carolinea*) *minor*, is remarkable for its lightness and almost corky texture, resulting from being composed almost exclusively of parenchymatous cellular tissue, with scattered porous ducts and true wood-cells. See WOOD.

BONE.—It need scarcely be stated that bone is the hard substance serving to give firmness to the bodies of the Vertebrata, to protect their delicate organs, and to form points of attachment for muscles.

Fig. 63.



Magnified 90 diameters.

Segment of the transverse section of a human metacarpal bone. *a*, outer surface of the bone, with the outer laminæ; *b*, inner surface next the medullary canal, with the inner laminæ; *c*, orifices of the divided Haversian canals, with their laminæ; *d*, interstitial laminæ; *e*, lacunæ, with their canaliculi.

To the naked eye, bone appears to consist of an apparently homogeneous basis, surrounding certain cavities, areolæ or *cancelli*; these are most numerous and larger towards the centre, where, in the Mammalia and Birds, they form a larger cavity called the medullary canal. This contains the marrow in the former class, but air in the latter. Hence we recognize in bone an outer compact and an inner spongy portion.

On examining a thin transverse section of bone under the microscope by transmitted light and with a low power, it is found to exhibit a number of round or oval apertures; these are the orifices of the divided vascular or *Haversian* canals (fig. 63*c*). These canals contain blood-vessels in the natural state. They are cylindrical, sometimes flattened, communicate freely with each other and the medullary canal, and also open upon the outer surface of the bone. They mostly run parallel with the axis in the long bones; whilst in the flat bones they are parallel to the surfaces, frequently following a radiating course. The branches by which they communicate with each other are either transverse or oblique, and pursue a radiating or tangential course.

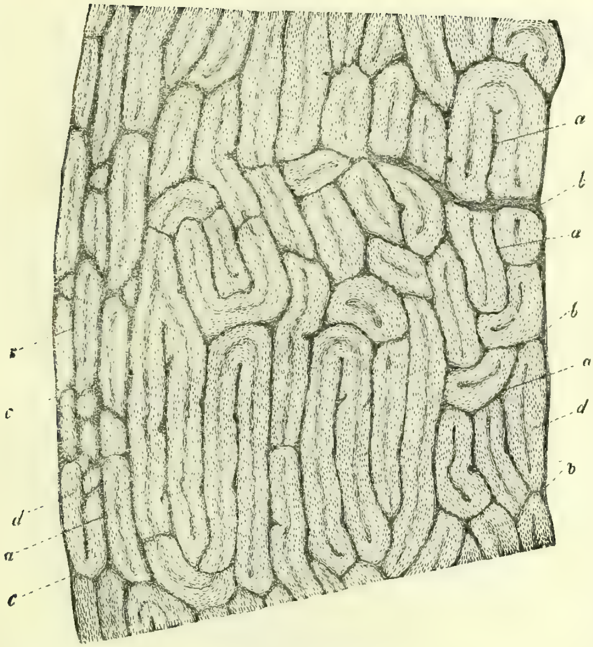
Hence in a longitudinal or superficial section of bone, the canals are seen running longitudinally, here and there connected by anastomosing branches, and forming elongated somewhat rectangular meshes (fig. 64).

Fig. 64.

Magnified 60 diameters.

Haversian canals from the superficial layers of a human femur, at eighteen years of age, treated with muriatic acid. *a*, Haversian canals; *b*, osseous substance with lacunæ.

Fig. 65.



Magnified 25 diameters.

Segment of a transverse section of the shaft of the human femur, at eighteen years of age. *a*, Haversian canals; *b*, their internal orifices; *c*, the external orifices; *d*, osseous substance, with lacunæ. There are no transverse sections of the Haversian canals, nor concentric laminæ.

When a section of bone is examined with a somewhat high power, it exhibits numerous dark spots, with fine lines branching from them on all sides; the former are the *lacunæ*, bone-corpuscles, or bone-cells (fig. 67 *c, b*), and the latter are the *canaliculi* or calcigerous canals (fig. 68 *b, c, d*). They derive their dark appearance in dried bone from containing air; if this be displaced by immersion in oil of turpentine, they become so transparent as to be scarcely distinguishable (fig. 66); and when examined by reflected light, they appear white. The lacunæ are generally longer than broad, and flattened. They are about 1-1100″ in length, 1-2000 to 1-2800″ in width, and 1-3800 to 1-6000″ in thickness; but their dimensions are subject to great variety. The canaliculi vary in breadth from 1-20,000 to 1-60,000″; and at their narrowest part, which is furthest from the lacunæ, they anastomose with those of the adjacent lacunæ.

In a transverse section of bone, the lacunæ of the laminæ surrounding the Haversian canals are seen to be placed tangentially to the orifices of these canals, as in figs. 66 and 68; whilst those of the laminæ near the surfaces are parallel with these surfaces (fig. 63).

In a longitudinal section made through the Haversian canals, they appear arranged in numerous longitudinal rows running parallel with the Haversian canals (fig. 67). The general arrangement is, that the long axis of the lacunæ is parallel with the laminæ in which they are contained, or between which they are situated.

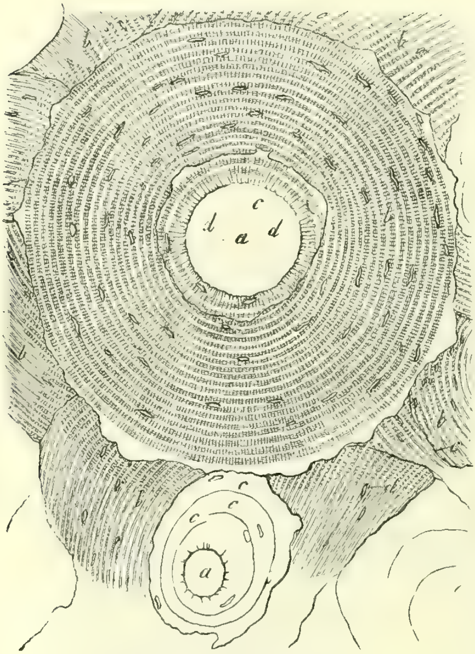
When the section coincides with the surfaces of a set of the lacunæ, they present a very elegant round or oval form (fig. 71), irregularly surrounded by a perfect tuft of canaliculi, which, being turned directly towards the observer, appear more or less shortened, and a small number of others, which are diffused through the surface of

In transverse sections of fœtal and incompletely developed bones, scarcely any of the apertures are met with, but the canals are seen pursuing a tangential or radial course (fig. 65 *a*); so that the bones appear to consist of short thick layers, each of which belongs to two canals, which separation is also indicated by a faint median line in each layer.

The Haversian canals vary considerably in size, from about 1-1000 to 1-200″.

The osseous substance or basis of bone possesses a laminated structure. The laminæ are visible in sections of dried bone (fig. 63 *a, b*), but much more distinctly in bone from which the inorganic matter has been removed by digestion in dilute muriatic acid. In this the laminæ are easily separable. They frequently exhibit a fibrous appearance; and near the surfaces of the bones they run parallel with these surfaces (fig. 63 *b*), but in the other portions they mostly surround the Haversian canals concentrically (fig. 63 *e*).

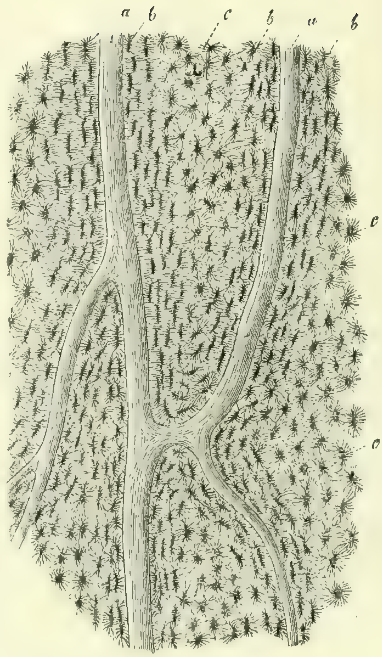
Fig. 66.



Magnified 350 diameters.

Portion of a transverse section of the shaft of the humerus, treated with oil of turpentine. *a*, Haversian canals; *b*, their laminæ, each lamina with a lighter and darker portion, and radiating striæ in the latter; *c*, darker lines, probably indicating greater interruptions in the deposition of the osseous substance; *d*, lacunæ without evident canaliculi.

Fig. 67.



Magnified 100 diameters.

Section of the surface of the shaft of the femur. *a*, Haversian canals; *b*, side view of the lacunæ in the Haversian laminæ; *c*, surface view of lacunæ.

the lamellæ. Here and there, in the thinnest portion of the section, a group of transversely divided canaliculi is seen (fig. 71 *a*, *a*), without the lacunæ to which they belong, giving the substance a sieve-like appearance. At the outer and inner surfaces of the bones, the canaliculi terminate by open mouths (fig. 69); and those nearest the Haversian canals open into them.

If the cartilage of bone be boiled for two or three minutes in water or a solution of caustic soda, the bone-cells and their nuclei are often rendered very distinct (fig. 70). After macerating bone in dilute muriatic acid also, the lacunæ, with longer or shorter processes, become isolated, and appear as independent formations.

In regard to the minute structure of bone, independently of the lacunæ and their canaliculi, a dry polished section exhibits a very delicate dotted appearance, which makes the bone appear granular, as if composed of closely aggregated pale granules, about 1-50,000 to 1-60,000″ in size. This is best seen in a transverse section.

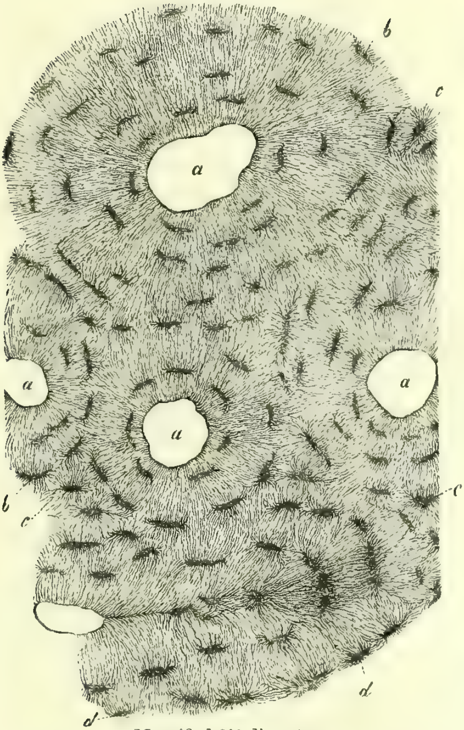
When bone is calcined and the residue is rubbed between two pieces of glass, or when bone is digested in a Papin's digester, minute inorganic granules are left; these are oval or oblong, frequently angular, and are about 1-10,000 to 1-20,000″ in diameter.

Hence bone probably consists of an intimate mixture of organic and inorganic matter, in the form of minute, firmly united granules.

The above remarks apply to human bones; and those of the other Mammalia agree essentially in structure with the former.

In Birds, the Haversian canals are more numerous and smaller than in the Mammalia, and frequently run in a direction at right angles to the shaft; the lacunæ are also more numerous and smaller, and the canaliculi very tortuous.

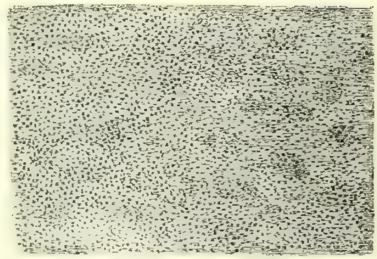
Fig. 68.



Magnified 300 diameters.

Part of a transverse section of the shaft of the humerus. *a*, Haversian canals; *b*, *c*, *d*, lacunæ with their canaliculi.

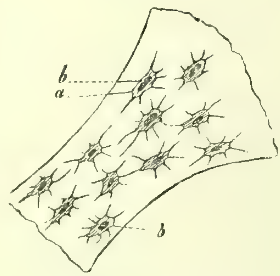
Fig. 69.



Magnified 350 diameters.

Portion of the onter surface of the tibia of a calf. The dots represent the orifices of the canaliculi, the larger dark indistinct spots are their lacunæ seen through the osseous substance.

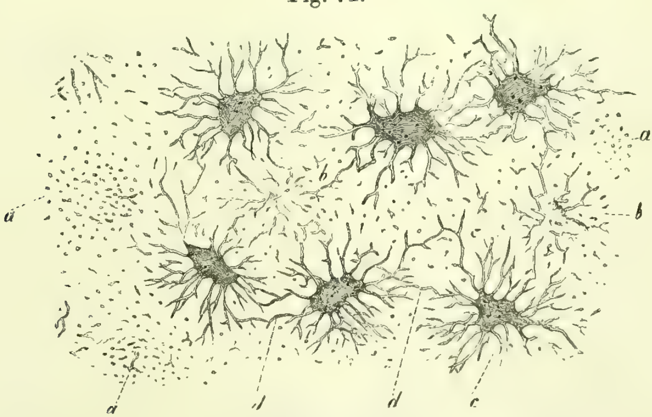
Fig. 70.



Magnified 350 diameters.

Cartilage of bone, after boiling in water *a*, lacunæ (bone-cells); *b*, nuclei.

Fig. 71.



Magnified 450 diameters.

Lacunæ (surface view) with the canaliculi, from the parietal bone. The dots seen upon or between the lacunæ represent divided canaliculi, or their orifices opening into the lacunæ; *a*, *a*, *a*, groups of transversely divided canaliculi.

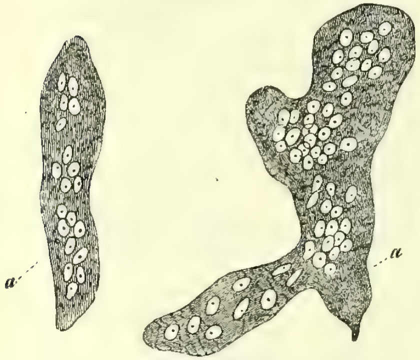
In Reptiles, the Haversian canals are few and very large, larger than in either of the other classes; the lacunæ and the canaliculi are also very large, and the latter very numerous.

In Fishes, the structure is more irregular: there are no concentric laminæ; the Haversian canals are sometimes absent, at others very large and numerous; frequently the lacunæ are absent, whilst the canaliculi are unusually long and elegantly wavy and branched.

The structures representing the bones in the Invertebrata are noticed under the respective classes.

The marrow or medullary tissue of bones consists of ordinary fatty tissue, free fatty matter, a particular liquid, and cells, with vessels and nerves, surrounded and traversed by a small quantity of areolar tissue. Some of the larger cells (?), found in fœtal bones, contain a large number of nuclei (fig. 72).

Fig. 72.



Magnified 350 diameters.

Peculiar granular cells, containing numerous nuclei, from the very young marrow of the flat bones of the human skull.

When animals, especially young ones, are fed with madder, the bones speedily acquire a beautiful red colour, principally around the Haversian canals, because it is here that the process of formation of new bone is most active; and the earthy matter precipitated from the blood carries down with it the colouring-matter of the madder.

The blood-vessels of bone which are distributed to the marrow (the nutrient vessels), enter particular canals on the external surface; whilst those connected with the Haversian canals are derived from the periosteum and those of the marrow. The two sets anastomose freely.

Chemically, bone consists of gelatine (not chondrine, as in cartilage), with phosphate of lime, small quantities of carbonate of lime, carbonate of magnesia, fluoride of calcium, and sometimes a little oxide of iron and magnesia.

By digesting bone with dilute muriatic or other acids, the inorganic matter is removed, and by treatment with solutions of alkalies or incineration, the organic substance or so-called cartilage may be separated.

In the *development of bone*, first the cells of the (primary) cartilage multiply by endogenous cell-growth, forming longitudinal rows or irregular heaps. These fuse and liquefy, so as to produce canals and cancelli, in which blood-vessels and medulla are formed. Earthy matter is then deposited in the cartilage, in a finely granular form (fig. 73); thus we have calcified cartilage,—but not bone. Absorption of the calcified cartilage next takes place, by which larger cancelli and canals are formed; and lastly deposition on the walls of the cancelli and canals, of generations of stellate (areolar) corpuscles (osteoblasts), forming a pseudo-cartilage, occurs, which becomes calcified to form the true bone; the absorption of the calcified cartilage, and the deposition in its place of the new tissue, continuing until the structure of the bone is perfected.

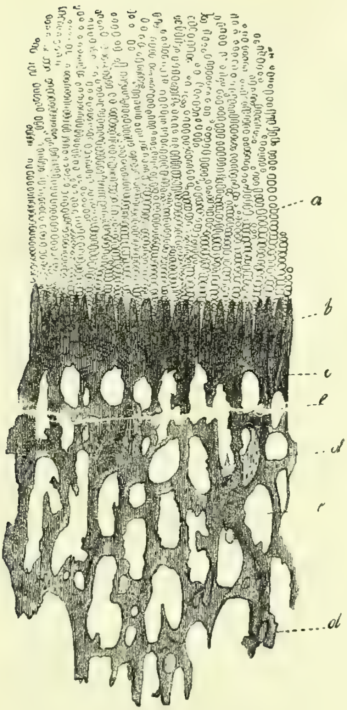
In certain morbid conditions, as in rickets, the development of the bone is arrested at the state of ossified cartilage, secondary deposit occurring in the cells of the primary cartilage as in the case of vegetable cells (fig. 74), the spaces left having great resemblance to the lacunæ and canaliculi of bone. But physiologists are not agreed upon the interpretation of the appearances presented by developing bone.

Adventitious bone agrees in general structure with the normal; it is met with in all stages of development.

To examine the structure of bone, thin sections are requisite. The method of making these is described under PREPARATION. By macerating bone in muriatic acid diluted with from 10 to 20 parts of water, the inorganic matter is removed, the cartilage being left. Thin sections of this can then be readily made.

The canaliculi are not easily seen when sections of bone are immersed in liquids; for these fill them up. But it is a difficult matter to measure the lacunæ, unless the

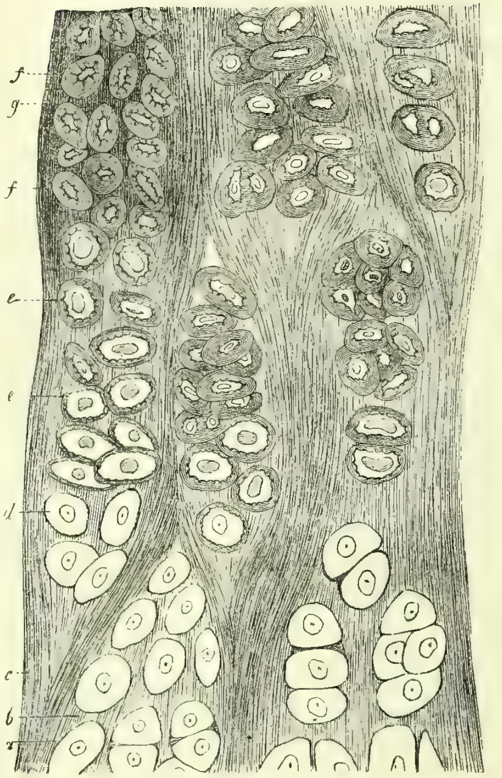
Fig. 73.



Magnified 20 diameters.

Perpendicular section of the margin of the shaft of the femur of a child, two weeks old, showing the calcification of cartilage. *a*, cartilage and its cells; *b*, margin of calcification; the dark stripes represent the calcification of the intercellular substance, which precedes that of the cartilage-cells indicated by the lighter portions; *c*, compact calcified layer near the calcifying margin; *d*, spongy substance with cancelli, *e*, formed by the absorption of the calcified substance.

Fig. 74.



Magnified 300 diameters.

Section of the margin of calcification of the condyle of the femur of a child two years old, affected with rickets. *a*, cartilage-cells, single and multiplying, in series; *b*, *c*, more or less striated intercellular substance; *d*, cartilage-cells at the very commencement of secondary deposition; *e*, the same in a more advanced state, with greatly thickened walls, indications of the canaliculi, and commencing deposition of calcareous salts in the walls, hence their darker colour, the nuclei still distinct; *f*, still more developed and calcified cells imbedded in the intercellular substance *g*, which is also becoming calcified.

section be moistened with turpentine or other liquid.

Very thin sections may be preserved in the dry state; those which are thick may be mounted in inspissated Canada balsam, which does not easily enter the canaliculi, yet greatly increases the general transparency of the section.

BIBL. Kölliker, *Mikr. Anat.* ii.; Tomes, *Todd's Cycl. Anat. and Phys.*, art. *Osseous Tissue*; Quekett, *Trans. Micr. Soc.* 1846; Paget, *Brit. and For. Med. Rev.* 1842; H. Müller, *Sieb. & Kölliker's Zeitschr.* ix. 147; Frey, *Histologie, &c.* p. 252, and the BIBL. therein. See CHEMISTRY.

BONNEMAISO'NIA, Ag.—A genus of Laurenciaceæ (Florideous Algæ), bearing pear-shaped spores in stalked ceramidia.

B. asparagoides is a sea-weed with a frond 4 to 12 inches long, growing near low-water mark or deeper, of delicate feathery character and deep crimson colour.

BIBL. Harvey, *Phyc. Brit.* pl. 51; *Brit. Marine Algæ*, p. 97, pl. 12 D; Greville, *Algæ Brit.* p. 106, pl. 13.

BORACIC ACID is the acid of the

well-known salt, borax, in which it exists combined with soda, in the proportion of two atoms of the acid to one of the base. Boracic acid is prepared by mixing three parts of borax dissolved in twelve parts of boiling water with one part of sulphuric acid or common oil of vitriol. As the mixture cools, the boracic acid separates in the crystalline form. It may be purified by re-solution in hot water, and subsequent cooling; finally, the crystals are pressed between blotting-paper, and dried. Boracic acid belongs to the doubly oblique prismatic system; and the crystals possess two optic axes. Those deposited from the hot aqueous solution are mostly six-sided plates; they exhibit the phenomena of analytic crystals, but at their lateral surfaces or edges only; and when their entire surface appears dark or coloured with the polarizer alone, the crystals are found to be laminated. But when an alcoholic solution of boracic acid is evaporated on a slide, or, still better, when some phosphoric acid is added to solution of borax, and the mixture evaporated, minute disks or spherules of the acid are formed; these, when carefully examined, are seen to be composed of minute needles radiating from a centre, exactly as in the oxalurate of ammonia. In some of them the needles are so closely in contact that they are undistinguishable and the circumference of the disk appears entire; in others, the free extremities of the needles are seen projecting beyond the circumference. They are perfectly colourless, and almost transparent when viewed by ordinary light, immersed in balsam. But when examined with polarized light, each disk exhibits the most beautiful cross and coloured rings, just as in the case of the oxalurate of ammonia, in which we have described the phenomenon more fully.

In some of the specimens of boracic acid the crystals form elegant arborizations, which also possess considerable analytic power.

The proportions of phosphoric acid and borax requisite to produce the disks cannot be laid down: they can only be prepared by accident in a number of trials. Even the same solution will sometimes yield them, at others not. Drops of the solution should be placed upon a number of slides, and these laid upon a warm iron plate. The disks are much more beautiful than those of oxalurate of ammonia, appearing more transparent and the colours more brilliant, probably from their being more highly refractive. They are difficult also to preserve. Even when mounted in Canada balsam, they deliquesce after a time, and large crystals take their place.

Bibl. Fox Talbot, *Phil. Trans.* 1837; Brewster, *Optics*, 1853.

BORRE'RA, Ach. (*Physcia*, Schreber).—A genus of Parmeliaceæ (Gymnocarpous Lichens), some species of which, such as *B. ciliaris* (fig. 397), *tenella* and *furfuracea*, are common on trunks of trees or old palings. *B. ciliaris* is an especially favourable lichen for observing the organs called *spermogonia* (see Lichenes). The specimens which possess these display them under the form of projecting brown or black tubercles upon the narrowest lobes of the thallus, mostly above. The largest size which they attain is about 1-25″ in diameter. Examined as opaque objects under a low power, they display pores or irregular fissures above. Fine sections examined under high powers as transparent objects, show that the fissures or pores lead into sinuous cavities lined by delicate filaments (*sterigmata*) bearing at their sides minute cylindrical corpuscles about 1-6000″ long (*spermatia*), which readily become detached, and exhibit a molecular motion in water.

Bibl. Systematic: Hook. *Br. Fl.* ii. part 1. 226; Schærer, *Enum.* &c. pp. 10, 11. pl. 2. fig. 1 (as *Physcia*); Lindsay, *Brit. Lichens.* Physiological: Hedwig, *Theoria Generationis*, p. 120, pl. 30, 31; Itzigsohn, *Botan. Zeit.* viii. 393, 913, ix. 153; Tulasne, *Mém. sur les Lichens*, 1852. 136, pl. 2. figs. 16, 17. (*Ann. des Sc. Nat.* 3 sér. xvii. p. 160. pl. 2. figs. 16, 17); De Bary, *Hofmeister's Handb. d. Bot.* ii. p. 274.

BOS'MINA, Baird.—A genus of Entomostraca, of the order Cladocera, and family Daphniadæ.

Char. Head terminated in front by a sharp beak directed forwards, and from the end of which project the long, many-jointed, curved and cylindrical superior antennæ; inferior antennæ two-branched, one branch with three, the other with four joints; five pairs of legs.

B. longirostris (Pl. 15. fig. 2). Superior antennæ with twenty joints.

Found in the New River, Hampstead ponds, and many clear waters. (Nat. size, fig. 2*.)

Bibl. Baird, *Brit. Entomostr.* p. 105; Leydig, *Naturg. d. Daphnid.* p. 244; Norman and Brady, *Brit. Entom.* (*North. and Durham Trans.* i. p. 5).

BOSTRYCH'IA, Fries. See Cytispora.

Bostrychia, Montagne, is a Florideous Alga =*Alsidium*, Agardh.

BOTHREN'CHYMA.—Pitted tissue of Plants. See TISSUE, Vegetable, and references under that head.

BOTHRIOCEPH'ALUS, Rudolphi.—A genus of Entozoa, of the order Sterelmintha, and family Cestoidea.

Char. Body long, flat, soft and jointed; head slightly tumid, oval or somewhat quadrangular, with two opposite depressions, or with four ear-like appendages, or with four depressions furnished with hooks; genital pores mesial.

The species are common in fish and birds, more rare in mammalia, and very rare in reptiles. They usually inhabit the alimentary canal, sometimes the abdominal cavity.

Thirty-four species are enumerated by Rudolphi, ten of which are doubtful. Dujardin enumerates twenty-three species.

Bothriocephalus latus (*Tænia lata*, the broad tape-worm) is met with in the human intestines. In it the head is somewhat ovoid, with two elongated opposite depressions, but no hooks; the neck generally not distinct. The joints of the body are very broad in proportion to their length. The orifices leading to the ovaries are situated in the centre of the flat surface of each joint; and around them the oviducts are seen, having a radiated or stellate appearance. Sometimes a minute body can be seen projecting from the genital pore—the male organ. It exclusively inhabits the small intestines. It is rare in England. It is sometimes 20 feet in length.

B. cordatus is found in dogs, and rarely in man (fig. in Leuckart, i. p. 438).

See TÆNIA and ENTOZOA.

BIBL. Rudolphi, *Entoz. Synops.*; Bremser, *Ueb. lebend. Würmer*, &c.; Dujardin, *Helminth.*; Eschricht, *Anat. Phys. Untersuch. ü. die Bothr.*; Blanchard, *Ann. des Sc. Nat.* 3 sér. xi.; Leuckart, *Mensch. Parasit.* i. p. 416; Cobbold, *Entozoa*, p. 289.

BOTRYCH'IUM, Swartz.—A genus of Ophioglossaceous Ferns. Moon-wort (*Botrychium Lunaria*) is an indigenous representative.

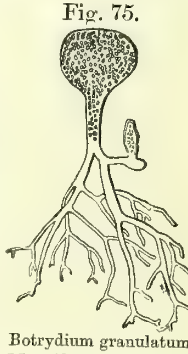
BOTRYDI'NA, Bréb.—A genus of Palmelleæ (Confervoid Algæ), consisting of one species of green microscopic plants, *B. vulgaris*, forming a somewhat gelatinous, blackish-green stratum on the ground, on trees, or on mosses, in damp places.

The spores, about 1-10,000″ in diameter, increase by cell-division till they form spherical bodies composed of many cells, the peripheral layer of which is diaphanous, the internal green from granular contents; the internal vesicles multiply, with constant increase of size of the whole, until the little fronds acquire the dimensions of a pin's head (1-36″ Kützing); the whole cellular structure is firmly coherent. These bodies require further study of development.

BIBL. Brébisson, *Nouv. Genr. d'Alg.* (1839), p. 3. fig. 3; Meneghini, *Monog. Nostoch.* p. 98, pl. 13. fig. 2; Hassall, *Br. Freshw. Algæ*, 320, pl. 81. fig. 2; Kützing, *Tab. Phycolog.* pl. 10.

BOTRYD'IUM, Wallr. (*Hydrogastrum*, Desv.).—A genus of Siphoneæ (Confervoid Algæ), of which one species is found in this country, growing upon damp, clayey ground, the dried-up bottoms of ponds, &c. A single plant, as developed from a spore or gonidium, exhibits a remarkable character, having a lower branched filamentous portion, growing in the ground, and an erect spherical or obovate portion, or head, about the size of a mustard-seed, or a little larger, of a bright green colour, the whole structure consisting merely of a single cell, with one continuous cavity running through the entire plant. The figure (fig. 75) represents such a specimen, with a second budding from it by vegetative increase; and in this way the plants come to form tufts or groups, like little bunches of grapes; hence the name. The cell-membrane acquires considerable thicknes; and at the period when it is softening, and about to dissolve to allow of the escape of the gonidia, it is seen clearly to be composed of numerous lamellæ, like that of *Hydrodictyon*. The globular head is lined, in the full-grown specimens, with a layer of protoplasm (primordial utricle), containing abundance of chlorophyl globules; and at a certain period this becomes broken up into numerous free globular portions, the *gonidia*. Itzigsohn states that he has seen these gonidia "swarm" out from the parent sac, but gives no details.

Fig. 75.



Botrydium granulatum. Magnified 10 diameters.

BIBL. Greville, *Algæ Brit.* 196, pl. 19;

Hassall, *Brit. Fr. Algæ*, 305, pl. 77. fig. 5; Kützing, *Nova Acta*, xix. pt. 2. pl. 69. figs. 1–10; Braun, *Verj. i. d. Natur*, pp. 136, 206, 236, 292; *Ray Soc. Transl.* (1853), pp. 128, &c.; Itzigsohn, *Bot. Zeit.* xiii. p. 257.

BOTRYL'LIDÆ.—A family of Tunicate Mollusca. Distinguished by the individual bodies being united into a common mass, which is attached; and by the mantle being united to the test at the orifices only.

These animals form translucent gelatinous or cartilaginous masses, of various hues of orange, purple, yellow, blue, grey, and green; and are found under stones, or rocks, or incrusting sea-weeds, near low-water mark. The bodies are often arranged in elegant star-like clusters or systems; the anal orifices usually terminating in a common central cavity or vent. Genera:

1. *Aplidium.* Form variable; systems numerous; central cavity none; bodies with thorax, fore and hind abdomen; branchial orifice six-rayed; anal simple and indistinct.

2. *Sidynum.* Incrusting; systems conical, truncate and starred at the summit, centre depressed; thorax and abdomen present; branchial orifice eight-rayed.

3. *Polyclinum.* Form variable; systems numerous, convex and radiating, with central cavity; bodies with thorax, fore abdomen, and long-stalked hind abdomen; branchial orifice six-rayed; anal projecting horizontally.

4. *Amaroucium.* Lobed or incrusting, sessile or stalked; systems numerous, with a central cavity; bodies as in *Aplidium.*

5. *Leptoclinum.* Thin, incrusting; systems numerous; bodies with thorax and abdomen; branchial orifice six-rayed; anal opening into a common vent, more or less branched.

6. *Distoma.* Sessile; cartilaginous form variable; systems numerous, circular; bodies in one or two rows at unequal distances from a common centre, with thorax and stalked abdomen; branchial and anal orifices six-rayed.

7. *Botryllus.* Incrusting, gelatinous; systems numerous; bodies horizontal, in stars round a common vent; bodies undivided; branchial orifice simple, remote from the vent.

8. *Botrylloïdes.* As the last, but stars irregular and ramifying; bodies vertical; orifices approximated.

9. *Syntethys.* Mass sessile, gelatinous, forming a single system; bodies sessile; orifices simple, without rays.

BIBL. See the Genera.

BOTRYLLOI'DES, M.-Edw.—A genus of Tunicate Mollusca, of the family Botryllidæ.

Char. See BOTRYLLIDÆ.

Four species: *B. Leachii*, hyaline, purplish, stars mottled white and yellow; *B. albicans*, transparent, stars white; *B. rotifera*, yellowish, systems speckled with red; *B. rubrum*, intense orpiment-red.

BIBL. Gosse, *Mar. Zool.* ii. 34; Forbes and Hanley, *Brit. Moll.* i. 23.

BOTRYL'LUS, Gaertn.—A genus of Tunicate Mollusca, of the family Botryllidæ.

Char. See BOTRYLLIDÆ.

Six species: *B. Schlosseri* (Pl. 43. fig. 20), stars numerous, individuals ten to twenty or more, yellowish and reddish, common; *B. polycyclus*, stars numerous, individuals eight to twenty or more, bluish, general; *B. violaceus*, *B. smaragdus*, and *B. bivittatus.*

BIBL. Gosse, *Mar. Zool.* ii. 34; Forbes and Hanley, *Brit. Mollusc.* i. 19.

BOTRYOCOC'CUS, Kützing. — Described as a floating genus of Palmelleæ (Confervoid Algæ), forming lobed and irregular bodies enclosed in a common large, hyaline, membranous sac, about 1-24″ in diameter, and containing a number of fixed granules, 1-7000 to 1-5000″ in diameter, of a bright or dark green or a red colour.

BIBL. Kützing, *Spec. Alg.* p. 892.

BOTRYOCYS'TIS, Kützing.—Described as a genus of Palmelleæ (Confervoid Algæ) found in stagnant fresh water, but apparently forms related to *Volvox.* See VOLVOCINEÆ.

Fig. 76.

Botryosporium pulchrum.
A fertile filament bearing sporiferous lateral branches.
Magnified 200 diams

BIBL. Kützing, *Sp. Alg.* p. 208; *Tab. Phyc.* pl. 9 and 10; Braun, *Verjüngung*, &c. p. 170; ibid. *Ray Translation*, 1853, p. 159.

BOTRYOSPO'RIUM, Corda (*Stachylidium*, Fries).—A genus of Mucedines (Hyphomycetous Fungi) allied to *Botrytis*, but distinguished by the lateral position of the sporiferous branches (fig. 76). British species:

1. *B. diffusum*, Corda (*Stachylidium diffusum*, Fr., *Botrytis diffusa*, Greville), forms loose white tufts, a quarter of

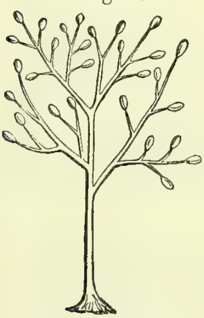
an inch high, on decaying herbaceous plants, especially potatoes.

2. *B. pulchrum,* Corda (fig. 76), forming mealy patches on living or decaying herbaceous plants.

Bibl. Corda in Sturm's *Deutschl. Fl.* iii.; *Prachtfl. Europ. Schimm.* p. 39; Greville, *Sc. Crypt. Fl.* t. 126. fig. 2; Currey, *Qu. Mic. Journ. Sc.* v. p. 117.

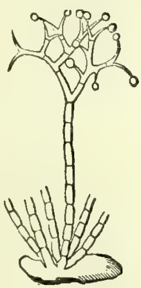
BOTRYTIS, Mich.—A genus of Mucedines (Hyphomycetous Fungi), among which are found some of the commonest moulds of decaying vegetable substances, and some very important parasitic fungi. Corda separated the species with the filaments continuous into a genus *Peronospora* (fig. 77), from those with articulate fila-

Fig. 77.



Botrytis (Peronospora). Magnified 200 diameters.

Fig. 78.



Botrytis. Magnified 200 diameters.

ments (fig. 78). Among the remaining forms are distinguished species of varying habit, separated by some authors under the name of *Polyactis* and *Haplaria.* The Potato-fungus, and the Muscardine of silkworms, are species of Botrytis, as described below; their natural history is further treated of under the head of Parasitic Fungi. The following have been described as British species:—

1. *B.* (*Haplaria,* Lk.) *grisea,* Fr. Fertile filaments simple or forked, grey, slender, rather rigid, septate, with little heaps of globose grey spores at the apices and sides. On decaying vegetables, usually on *Sparganium* and allied plants. Corda, *Icon. Fung.* i. pl. 4. fig. 246.

2. *B. cinerea,* Pers. Fertile filaments gregarious, almost simple, cinereous, soon strangulated, with white spores attached here and there. Not uncommon on stems of herbaceous plants.

3. *B. cana,* Schmidt. Fertile filaments cinereous or whitish, branched at the apex; spores large, oval. On rotting stems and leaves. *Mucor racemosus,* Bulliard, t. 504. fig. 7.

4. *B. vulgaris,* Fr. Fertile filaments grey, divided at the apex into lobe-like branches, on which are collected the globose minute spores. Common on rotting plants. *B. acinorum,* Pers. Fresenius, *Beitr. z. Mycologie,* i. pl. 2. (?) *Polyactis vulgaris,* Nees, *Syst.* fig. 57.

5. *B. vera,* Fr. Fertile filaments grey, branched above, forming spikes about the slender apices. On decaying substances, fungi, &c. *Mucor Botrytis,* Bolton, pl. 132. fig. 3.

6. *B. crustosa,* Fr. Fertile filaments white, simple, trifid and verticillate; spores globose, terminal. On stems and leaves.

7. *B. citrina,* Berk. Mycelium white; fertile filaments erect, articulated, branched; branches subcymose, and, like the obovate spores, lemon-coloured. On dead branches of cherry-trees. Berkeley, *Ann. Nat. Hist.* i. p. 262, pl. 8. fig. 12.

8. *B. terrestris,* Pers. Fertile filaments white, quaternately divided at the tips, each tip bearing a single globose spore. On rotten sticks. Berk. *l. c.* pl. 14. fig. 24; *Stachylidium terrestre,* Grev. *Sc. Crypt. Flora,* pl. 257.

9. *B. urticæ,* Libert, MSS. (Berk.). Fertile filaments greyish lilac, loosely divided above; branches forming an acute angle; extreme branchlets simple or forked, sometimes curved, rarely inflated; spores large, ovate, apex papilliform. On nettle-leaves. Berk. *Ann. Nat. Hist.* ser. 2. vii. p. 100.

10. *B. Jonesii,* Berk. and Br. Fertile filaments erect, fawn-coloured, branched above; branches and branchlets divergent, mostly opposite, the last fasciculated, the centre always sterile and very acute; spores roundish, spiny. On dung. *Ann. Nat. Hist.* 2 ser. xiii. pl. 15. fig. 12.

11. *B. Tilletii,* Desm. Fertile filaments branched, fulvous; branchlets very short, whorled; spores subglobose. On mosses and various leaves. Desmaz. *Crypt. Exs.* fasc. v. No. 226; *Ann. des Sc. Nat.* 2 sér. x. 308.

12. *B.* (*Peronospora*) *parasitica,* Pers. Fertile filaments white; branches ramulose; spores very large, globose. Caspary has found here cysts containing minute spores (*sporidangia*). On Cruciferæ (turnips, cabbages, &c.). Berkeley, *Journ. Hort. Soc.* i.

pl. 4. fig. 26; Corda, *Icon. Fung.* v. pl. 2. fig. 18. *Mucor Botrytis*, Sowerby, pl. 359.

13. *B.* (*Peronospora*) *effusa*, Greville. Fertile filaments purplish-grey, branched above; branches short, divaricate; spores large, oval. Frequent on the lower face of leaves of spinach.

14. *B.* (*Peronospora*) *curta*, Berk. Fertile filaments simple, abbreviated, denticulate at the tips, grey-brown; spores oval. On *Anemone nemorosa*, Berk. *Ann. Nat. Hist. l. c.* pl. 8. fig. 13.

15. *B.* (*Peronospora*) *destructor*. Fertile filaments grey, erect, scarcely septate; branches alternate, the last forked, hooked, and divaricated; spores obovate, much attenuated at the base. Very destructive on species of *Allium* (onions, &c.). Berk. *Ann. Nat. Hist.* vi. p. 436, pl. 13. fig. 23.

16. *B.* (*Peronospora*) *Arenariæ*, Berk. White; fertile filaments dichotomous above, divaricate-forked, not hooked at the tips; spore ovate. On the leaves of *Arenaria trinervis*. Berk. *Journ. Hort. Soc.* i. 31, pl. 4. fig. 22.

17. *B.* (*Peronospora*) *Viciæ*, Berk. White; fertile filaments sparingly branched, elongate; branchlets bifid, not hooked; spores obovate, apiculate. On common Vetches (a distinct species, purple, is said to grow on peas). Berk. *l. c.* pl. 4. fig. 23.

18. *B.* (*Peronospora*) *arborescens*, Berk. White; fertile filaments very much branched above, di- trichotomous, somewhat forcipate at the apex; spores smallish, subglobose. On common red poppy leaves. Berk. *l.* c. pl. 4. fig. 24.

19. *B.* (*Peronospora*) *ganglioniformis*, Berk. White, in patches; fertile filaments branched above; branchlets curved, dilated in ganglioid thickenings below the tips; spores small, subglobose. On lettuces. Berk. *l. c.* pl. 4. fig. 25. *B. geminata*, Unger, *Bot. Zeitung*, v. pl. 6. fig. 9. *Bremia lactucæ*, Regel, *Bot. Zeit.* 1843, i. p. 665, pl. 3 B.

20. *B.* (*Peronospora*) *macrospora*, Ung. Fertile filaments erect, several from the same point, white, branched above; spores very large, elongate-pyriform. On leaves of parsnips and other Umbelliferæ. Unger, *Exantheme*, pl. 2. fig. 14 B.

21. *B.* (*Peronospora*) *infestans*, Montagne (Pl. 20. figs. 5–7). The Potato-fungus. This grows in tufts on the lower surface of the leaves, and also on the tubers of the potato, forming white mealy spots. The mycelium ramifies in the intercellular passages of the leaves, and sends out the fertile filaments from the stomates, so that these appear scattered among the hairs of the epidermis; they are usually about 1-30″ high upon the leaves, branched at the apex, septate and white. The 2 to 6 branches are erecto-patent, acute, virgate, nodose from numerous elliptical thickenings. The spores in large specimens are at first globular-ovoid, then elliptical, and finally somewhat of the shape of a gourd-seed, with a subapiculate mamilla at one end, very shortly pedicellate at the other, of the same colour as the filaments, chiefly white, densely filled with sporules enclosed in an endospore, about 1-800″ long, 1-1200″ thick. These sporules have been shown by De Bary to be zoospores when fully developed. Besides the normal spores, there are resting spores in many *Peronosporæ*, which have been described by the same author in *Ann. d. Sc. Nat.* 1863, xx. p. 10. *Artotrogus* of Montagne is probably the resting-spore of *Peronospora infestans*. Berkeley, *Journ. Hort. Soc.* i. 30, pl. 2–4. figs. 4–19. *Botrytis Solani*, Auct., var. *B. fallax*, Desmazières. *B. devastatrix*, Libert; Morren, *Ann. de la Soc. de l'Ag. de Gand*, 1845, p. 287; *Peronospora trifurcata*, Unger, *Botan. Zeit.* v. 314, pl. 6. figs. 1–6.

Botrytis Bassiana, Balsamo, is the fungus growing in the bodies of silk-worms, causing the disease called *Muscardine*, which sometimes produces most extensive destruction in the districts where they are cultivated. A figure of it is given by Mr. Berkeley in the paper on the Potato-fungus referred to above. Many papers on it exist in the *Comptes Rendus*; and the whole history, with figures, will be found in Robin's *Végétaux Parasites*, 2nd ed. 1853, p. 560 *et seq.*

Botrytis lateritia, Fr., not uncommon in the hollows of decaying potatoes, beet-root, &c., appears to be a form of *Acrostalagmus parasitans*, Corda. See ACROSTALAGMUS.

The genus *Botrytis*, like many other genera, has been divided and subdivided till the genus itself has almost vanished. It is restricted in the 'Outlines of British Fungology' to those species which have septate, hyaline or coloured threads, with terminal spores, as *B. Tilletii*, *citrina*, *Jonesii*, and *terrestris*. Several of the so-called species are states of Ascomycetous Fungi. See Tulasne, *Carpologia*, vol. iii.

BIBL. As given under the species. Fries, *Summa Veget.* p. 490; Berkeley, *Crypt. Bot.* p. 307.

BOUGAINVIL'LIA, Lesson.—A genus

of marine Polypes, of the order Hydroida, and family Atractylidæ.

Char. Stem branched, rooted by a filiform stolon; polypes fusiform; a single wreath of filiform tentacles around the base of the conical proboscis. Three British species.

BIBL. Hincks, *Hydr. Zooph.* p. 108.

BOWERBAN'KIA, Farre.—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Ctenostomata, and family Vesiculariadæ.

Distinguished by the matted and creeping or erect and irregularly branched polypidom, the tubular densely clustered cells, and the ten tentacles and strong gizzard.

B. imbricata (Pl. 43. fig. 19), the only species, has the cells ovate or ovato-cylindrical, in dense clusters irregularly scattered on the polypidom.

Parasitic on other Polyzoa, Polypi, and Algæ. Polypidom in the young state creeping and matted, and formerly regarded as a distinct species (*B. densa*); in the adult condition forming bushy confervoid flaccid tufts, an inch and a half high, much and irregularly branched. Branches smooth, transparent and hollow, cells aggregated on one side.

It forms a favourable object for the study of the structure of the Polyzoa, on account of its transparency.

BIBL. Johnston, *Brit. Zooph.* 377; Farre, *Phil. Trans.* 1837, 391; Gosse, *Mar. Zool.* ii. p. 21.

BOX.—The wood of the box-tree, *Buxus sempervirens*, L. (Nat. Ord. Euphorbiaceæ, Dicotyledon), is remarkable for its hardness, offering a great contrast to that of *Bombax* and the like. See WOOD.

BRACHIONÆ'A.—A family of Rotatoria.

Char. A carapace (testula) present; rotatory organs two, simple.

The rotatory organ sometimes appears to consist of five parts, three median and two lateral. The two larger lateral ones only are rotatory organs, the cilia of the median ones remaining extended without motion during the action of the other. The carapace resembles that of a tortoise.

Genera:

Eye-spots absent; foot forked			*Noteus.*
Eye-spots present	one	foot absent	*Anuræa.*
		foot forked	*Brachionus.*
	two	foot absent	*Pompholyx.*
		foot styliform	*Pterodina.*

See HYDROCORA and DIPODINA.

BRA'CHIONUS, Hill.—A genus of Rotatoria, of the family Brachionæa.

Char. A single eye-spot at the back of the head; foot forked.

The anterior margin of the carapace is furnished with teeth, as in some species is the posterior margin also.

B. amphiceros (Pl. 34. fig. 8). Carapace smooth, furnished both at the anterior and posterior margin with four teeth; aquatic; length 1-70''.

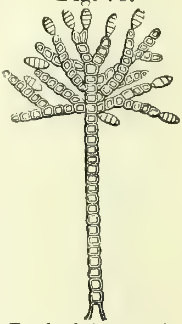
B. rubens. Carapace smooth, with six acute teeth in front, and rounded posteriorly; body reddish; aquatic; length 1-50''. (Teeth, Pl. 34. fig. 9.)

Eleven other species have been described; some of them aquatic, others marine.

BIBL. Ehrenb. *Infus.*; Dujardin, *Inf.*; Gosse, *Ann. Nat. Hist.* 1851, viii. p. 202; Cohn, *Sieb. & Köllik. Zeitsch.* vii. p. 459.

BRACHYCLA'DIUM, Corda.—A genus of Dematiei (Hyphomycetous Fungi), not separated by any marked characters from DENDRYPHIUM, forming a delicate mould on dry stems of herbaceous plants. The filaments and branches are formed of squarish cells, swollen so as to produce a moniliform appearance, the walls being thick and coloured.

Fig. 79.



Brachycladium penicillatum.
An erect filament with fertile branches.
Magnified 200 diameters.

The so-called species are probably stages of Ascomycetous Fungi.

B. penicillatum, Corda, is said to extend over stems, sometimes in tracts a foot long; the filaments and branches are blackish, the spores white (fig. 79).

BIBL. Corda, *Icones Fung.*; Fries, *Summa Veget.* p. 504.

BRA'CHYODUS, Nees.—A genus of Leptotrichaceous Mosses, separated from *Gymnostomum* or *Weissia* of some authors.

BIBL. Wilson, *Bryol. Brit.* p. 52.

BRACHYSTE'LIUM, Reichb.—A genus of Orthotrichaceous Mosses.

1. *Brachystelium polyphyllum*, Hsch. = *Ptychomitrium polyphyllus*, Br. and Sch.

BIBL. Wilson, *Bryol. Brit.* p. 173.

BRACHYTHE'CIUM, Br. and Sch. = HYPNUM.

BIBL. Wilson, *Bryol. Brit.* p. 337.

BRADYCINE'TUS, Sars.—A genus of Entomostraca, of the order Ostracoda (section Myodocopa) and family Cypridinidæ. Characterized by the 2-branched lower antennæ, and the one pair of feet. *B. brenda* = *Cypridina brenda*, Baird; *B. Macandrei* = *Cyp. Mac.*, B.

BIBL. Brady, *Linn. Trans.* xxvi. p. 466.

BRAIN. See NERVES.

BRAN. See CORN.

BRAN'CHIÆ.—This term is synonymous with gills. The latter term, however, is usually applied to the aquatic respiratory organs of fishes, whilst those of other animals retain the name of branchiæ. Their structure is described with that of the respective classes in which they occur. See also EPHEMERA and LIBELLULIDÆ.

BRAN'CHIPUS, Schæffer (*Chirocephalus*).—A genus of Entomostraca, of the order Phyllopoda, and family Branchipodidæ.

Char. Abdomen prolonged in the form of a tail, composed of nine segments or joints, the end joint with two well-developed plates or lamellar appendages; superior antennæ, in both sexes, slender, filiform, and many-jointed; inferior antennæ in the male large, curved downwards, two-jointed, furnished at the base with fan-shaped and digitiform appendages; in the female, stout, short, somewhat acute, slightly curved, and not furnished with appendages at the base.

B. stagnalis (Pl. 15. fig. 3). An inch in length; tinged with red.

This beautiful animal is found in stagnant water, as the ditches and deep cart-ruts on the edges of woods and plantations.

B. rubricaudatus, Kl. Ovarian sac and tail-fork red; the former long, cylindrical, terminating in a curved prickle.

In rain-water, at Kossier (Red Sea).

BIBL. Baird, *Brit. Entom.* p. 39; Klunzinger, *Sieb. & Köll. Zeitsch.* xvii. p. 23.

BRAND.—A disease of Cereal Grasses and other plants depending on Fungi. See BLIGHT.

BREAD.—The interest of microscopic examination of bread depends chiefly on the impurities it may contain, or the peculiar Fungi developed in it during decay. The commonest intentional adulteration of bread is the addition of mashed potatoes to the flour. The cells of the potato are recognizable in bread after the starch has been dissolved and washed away. The adulteration of the flour with other meals is easily ascertained before it is made up, but the baking greatly affects the forms of the starch-granules. See STARCH.

The spores of the parasitic Fungi of wheat (UREDINEI, USTILAGINEI), pollen-grains, and other vegetable bodies are occasionally met with as accidental impurities, and are present in large numbers in inferior and "damped" flours.

The fermentation of bread depends upon the development of the YEAST fungi in the dough: an account of this will be found under that head, and FERMENTATION.

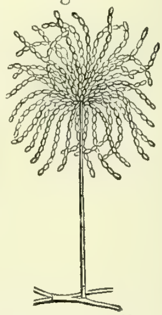
Mouldy bread presents various microscopic fungi in a mature condition, some evidently the fruit of the yeast-plants, PENICILLIUM, MUCOR, &c.; others, like the so-called 'blood on bread,' appear to be peculiar states of the vegetative structure of the same Fungi.

BREUTE'LIA, Br. and Sch. = BARTRAMIA.

BIBL. Wilson, *Bryol. Brit.* p. 283.

BRIA'REA, Corda.—A genus of Mucedines (Hyphomycetous Fungi), nearly related to *Penicillium*, *Aspergillus* and *Monilia*, distinguished from the first and last by the moniliform rows of spores arising, directly, in a terminal tuft, while the erect fertile filament is not expanded into a capitulum to bear them, as is the case in *Aspergillus*. British species:—

Fig. 80.



Briarea penicillata.
Magnified 200 diameters.

Briarea penicillata (fig. 80), (*Monilia*, Fries, *Aspergillus*, Greville). The erect filaments are simple and geniculate, the spores hyaline, forming long nodding moniliform rows. It is of dark grey colour, and is found on damp grass, mouldy hay, straw, &c.

BIBL. Corda, *Icones Fung.* v. 16, and in Sturm, *Deutschl. Flor.* ii. pl. 6; Greville, *Sc. Crypt. Flora*, t. 32; Berk. in *Hook. Br. Fl.* 345.

BRIGHTWELLIA, Ralfs.—A genus of Diatomaceæ.

Char. Valves disk-shaped, with a large granulated centre, separated from a broad punctate limb by a ring of oblong cells.

B. coronatus, *Mic. Trans.* viii. p. 95, pl. 5. f. 6; *B. elaborata*, ibid, 1861, p. 73; *B. Johnsoni*, ibid. vi. p. 4.

BIBL. Ralfs, *Pritchard's Infus.* p. 940.

BRINE-WORM. See ARTEMIA.

BRISTLE. See HAIRS.

BROMELIA'CEÆ.—A family of Monocotyledons (Flowering Plants), of which the Pine Apple, *Ananas* or *Ananassa*, is the most familiar example. This is interesting microscopically from the scurfy character of the epidermis of the leaves, dependent on peculiar cellular scales. The cells of the epidermis are of very elegant form (Pl. 38. fig. 15); and the fibres of the leaf are manufactured into very fine muslin. See SCALES, EPIDERMIS, and FIBRES.

BRONCHI. See LUNGS.

BRONCHOCER'CA.—*Monocerca* with the caudiform foot cleft at the end. Five species have been described; but it appears that they do not differ by well-marked characters from the species of *Monocerca*.

BIBL. Werneck, *Ber. d. Berl. Akad.* 1841, 377.

BROOKE'S APPARATUS. INTRODUCTION, p. xix.

BRUCHIA'CEÆ.—A family of inoperculate Acrocarpous Mosses, gregarious or cæspitose and terrestrial, in which the fruit-stalks sometimes appear lateral, through arising from innovations. The stems dwarf, either simple or branched by innovations; the leaves lanceolate or awl-shaped from a more or less oval base, composed of parenchymatous cells, larger and sometimes lax at the base of the leaf, smaller and squarish toward the apex, and furnished with a flattened broad nerve (fig. 49), and standing up like bristles; the perichætial leaves broader at the base and sheathing; all of firm membranous character, shining and smooth. Capsules oval or globose, mostly straight-beaked (fig. 50). British genera:—

1. *Archidium*. Calyptra completely enclosing the (globose) capsule, bursting above. Inflorescence monœcious, bud-shaped.

2. *Astomum*. Calyptra dimidiate. Capsule equal. Inflorescence either monœcious, gemmiform and axillary, or with the antherids and archegones together.

BRU'CHUS, Lin.—A genus of Coleopterous Insects.

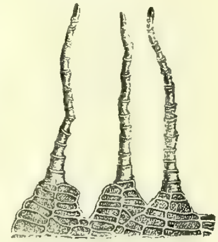
B. pisi is a common small beetle; black, mottled with white. The larva feeds upon peas. Several other species.

BIBL. Stephens, *Brit. Coleopt.* p. 264; Boisduval, *L'Entomol. Horticole*, p. 157.

BRU'CIA. See ALKALOIDS.

BRYA'CEÆ.—A family of operculate Mosses, acrocarpous, or by innovation pleurocarpous, with lanceolate, oval, round or spathulate leaves, composed of cells parallelogrammic below, rhomboidal-parenchymatous above, more or less dense, with much chlorophyll or a persistent primordial utricle, or at length empty, very smooth. Capsule more or less pear-shaped, clavate, oval or cylindrical, with a hemispherical or conical operculum, erect, nodding or pendulous. External peristome, when present, soft, lamellose, internal membranous. British genera:—

Fig. 81.



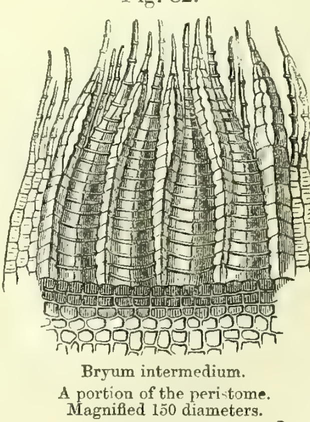
Mielichoferia nitida.
Teeth from the peristome.
Magnified 150 diameters.

I. *Mielichoferia*. Calyptra conical-dimidiate, split at the side. Peristome wanting or simple, then of sixteen equidistant, filiform, flattish, articulated pale teeth, sometimes placed on a short, sulcate, reticulate basilar membrane (fig. 81). Capsule lateral, with a double annulus.

II. *Orthodontium*. Calyptra smallish, hood-shaped, fugacious. Peristome arising below the orifice of the capsule, double; external: of sixteen lanceolate-subulate teeth, like those in *Bryum*; when dry, deflexed below the orifice of the capsule, when moistened, erect; internal: cilia alternating with the external teeth, half as long or about equal, filiform, from a short, somewhat keeled membrane. Capsule annulate or exannulate, with a longish collum.

III. *Bryum*. Calyptra dimidiate, smallish,

Fig. 82.



Bryum intermedium.
A portion of the peristome.
Magnified 150 diameters.

hood-shaped. Peristome double (fig. 82); external of sixteen lanceolate, soft, yellowish equidistant teeth, flat on the back and transversely trabeculated, with a flexuous longitudinal line in the middle, lamellate within, hygroscopic; internal a large delicate membrane with sixteen keels, produced into more or less perfect lanceolate teeth, often with intermediate cilia, sometimes without. Capsules mostly annulate.

Bibl. See Mosses.

BRYOP'SIS, Lamouroux.—A marine genus of Siphoneæ (Confervoid Algæ), of which the British species form beautiful green, somewhat elastic, feathered silky tufts, from 1 to 4″ high upon rocks or upon other Algæ, in tide-pools. The whole axis and proper branches of each plant consist of one large ramified cell, the cavity being continuous throughout, the membranous wall rather thick, somewhat gelatinous externally; the branches are naked below, but clothed above by small ramuli, arranged like leaves, distichously, spirally, or irregularly. The main axes and branches grow indefinitely by development of the apices; the ramuli are limited in their development, and they are ultimately shut off by septa, at last falling off by the circular rupture of their wall, just above their point of origin.

When examined early, the ramuli are found to have their walls lined with largish elliptical green grains, each of which has at first a round light central body, colourable blue by iodine when fully formed (starch-corpuscle). The branches exhibit the phenomenon of reproduction, in irregular order, in the following way. The green bodies on their walls multiply by subdivision, and increase in size and number until they completely fill the tubular cavity of the ramule, pressing upon one another so as to form a compound dark green mass. A peculiar swarming movement is next observed in the green bodies, which increases more and more, and, the parent tube opening by a pore near its apex, the green bodies escape as elongated pear-shaped zoospores or active gonidia with cilia, according to Thuret, two and four in *B. hypnoides*, only two in *B. plumosa*. The successive emission of the gonidia from the various tubes of one plant occupies several days.

After the gonidia have come to rest, they acquire a spherical form, and gradually increase in size; at the end of a month or six weeks their diameter is twice or thrice the original dimensions, and then they begin to elongate into a tube similar to the parent. Agardh found them elongate, either in one direction or in two, at first; but one end soon swelled into a thickened organ of attachment, while the other began about the sixth week to branch. British species:—

1. *B. plumosa*, Huds. Deep green, 1 to 4 inches high, more or less branched: the branches pinnated with subopposite distichous or rarely irregular ramules. Harvey, *Br. Mar. Algæ*, 2nd ed. pl. 24 B; *Phycol. Brit.* pl. 3; Greville, *Algæ*, pl. 19; *Engl. Bot.* (*Ulva plumosa*), 2375.

2. *B. hypnoides*, Lamour. Yellow-green, 2 to 4″ high, more slender and more branched, branches repeatedly divided, ramules irregularly scattered, somewhat pinnate, more or less dense. Harvey, *Phyc. Brit.* pl. 119.

Bibl. Systematic, *as above*, and Kützing, *Sp. Alg.* p. 490; Physiology, &c., Agardh, *Ann. des Sc. Nat.* 2 sér. vi. 200, pl. 12; Nägeli, *Zeits. für Wiss. Bot.* 1844–46 (*Ray Soc.* 1845, p. 269, pl. 6. figs. 11, 12, 1849, p. 97, pl. 2. figs. 1–3); *Neu. Algen-Systeme*, Zurich, 1847, p. 171, pl. 1. figs. 44–56; Thuret, *Ann. d. Sc. Nat.* 3 sér. xiv. 8, pl. 16. figs. 1–6; Braun, *Verj.* 137, &c. (*Rejuv.* &c., *Ray Soc.* 1853, p. 129, &c.).

BRYOZO'A. See Polyzoa.

BRY'UM, Dill.—A genus of operculate Mosses, usually acrocarpous, containing a large number of British species, even in its restricted condition.

Among the most common of these are *B. nutans, cernuum, intermedium, capillare, cæspititium*, &c. Many of the older species are now included under Mnium.

Bibl. Wilson, *Bryol. Brit.* p. 221.

BUC'CINUM, L.—*B. undatum*, the common Whelk. The tongue forms an interesting microscopic object.

BUDS.—The buds of plants form interesting objects of microscopic investigation on many accounts,—first in tracing the development of the organs, and also of the tissues of which these are formed; secondly, on account of certain temporary structures which they exhibit. The thick epidermis of the scales of the winter-buds of ordinary trees, as of the ash, &c., is a very favourable object for sections to show the character of this tissue when highly developed. The internal soft scales and young leaves of very many of these winter-buds, as well as other buds of herbaceous plants, are clothed with glandular hairs, which disappear when the buds are expanded; and these often

afford advantageous material for studying cell-development. These glandular hairs were mistaken by Grisebach (*Botan. Zeit.* ii. p. 661, Sanderson, *Ann. Nat. Hist.* 2 ser. xvi. p. 141) for bodies analogous to the antheridia of Mosses. See GEMMÆ.

BUG. See CIMEX.

BU'GULA, Oken (*Cellularia* part, Johnston).—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata, and family Bicellariadæ.

Distinguished by the elliptical closely contiguous cells in two or more rows, the very large orifice with a simple not thickened margin, and the stalked, jointed, frequently blue or red avicularia (generally present).

1. *B. neritina.* Cells quadrangular, elongate, truncate at ends, angles projecting. Rare.

2. *B. flabellata.* Cells in many rows, oblong, truncate at ends, with one or two spines at upper angles; orifice extending to the base; avicularia on the sides of the cells capitate, surface smooth; ovicells cucullate, with a very wide orifice.

3. *B. avicularia* (*Cellularia avic.*, Johnston). Cells in two rows, elongate, contracted below; orifice not reaching quite to the base, obovate; with two spines on the outer side, and one on the inner above; avicularia lateral, capitate, surface granular or areolate; ovicells superior, subglobular; orifice small. Deep water.

4. *B. plumosa.* Cells elongate, narrowed below, with a spine at upper and outer angle; orifice as wide as the cell above, elliptical below; avicularia capitate, close to outer margin of the orifice; ovicell superior, globular.

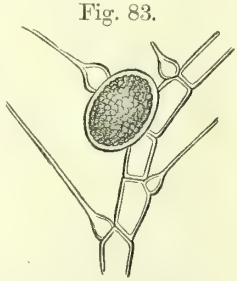
5. *B. Murrayana* (*Flustra Mur.*, Johnst.). Cells in many rows, narrowed about the middle and below; orifice oval, with one to four incurved marginal spines on the outer and one on the inner edge; a strong hollow spine on each side of the top of the cell, and a capitate avicularium on the front of some of the cells below the orifice. Very rare.

BIBL. Busk, *Mar. Polyzoa* (*Brit. Mus.*), 43; Johnston, *Brit. Zooph.*

BULBOCHÆ'TE, Ag.—A genus of Œdogonieæ (Confervoid Algæ), distinguished by the branched habit, and by the cells resembling bristles with a bulbous base situated at the tips of lateral shoots. They form villous tufts 1-4 to 1-2″ high on freshwater plants in lakes and pools.

The cells of the main filament multiply in the same way as those of ŒDOGONIUM, under which head the process is minutely described. The parent-cell breaks by a circumscissile dehiscence to allow the expansion of the two new cells. The bristles which are formed at the upper ends (alternately on each side of the filament (fig. 83)) likewise break out from a slit in the cell from which they arise. The bristle is sometimes sessile on the cell from which it arises; sometimes multiplication takes place at its base, so that one or more cells are interposed; the bristle is always the oldest part of the branch.

Fig. 83.



Bulbochæte setigera.
Portion of a filament with a sporiferous cell.
Magnified 150 diameters.

These plants are multiplied by zoospores, and by resting-spores formed after fertilization by the contents of antheridial cells. The zoospores are formed from the whole contents of a globular or oval cell produced between the bristle-cell and the cell on which it is attached, which dehisces by a circular slit, causing the upper part with the bristle to separate, and allowing the single zoospore, crowned by a wreath of cilia (as in *Œdogonium*), to escape into the water, where it moves actively for a time, acquires a cellulose coat, and then germinates into a new filament. We have not space to give the details of the development of the parent-cell of the zoospore, which, however, are very interesting.

The resting-spores are formed, in the first place, somewhat in the same way and in the same situations as the zoospores, but the cell-contents do not escape. An orifice is formed in the wall of the parent-cell, through which penetrate the spermatozoids coming from the antheridia. The spore-mass then becomes encysted, and its contents are changed, the green colour arising from the presence of chlorophyl giving place to a brown tint. The resting-spore ultimately escapes by the rupture of the parent-cell (*oogonium*, Pringsheim); and in its germination (in the following season) the contents are developed into four zoospores, which escape from the spore-membrane and grow up singly into new plants (Pl. 45. fig. 22).

The history of the antheridia of the Œdo-

gonieæ is somewhat complicated. In the present genus a few short cylindrical cells are developed underneath the bristle-cell, either on special branches or on the sporangial branches, between the parent-cell of the spores and the bristle. These cells break by circumscissile dehiscence, and discharge their contents in a form exactly resembling the vegetative zoospores, but much smaller. These ultimately come to rest, and commonly attach themselves to germinate upon the walls of the parent filament, often on the outside of the mother-cell of the spore. When they germinate, they become short filaments composed of one, two or several cells, in each of which is developed one or two spermatozoids, which are minute globular active bodies with a wreath of cilia, almost colourless, but in other respects resembling the much larger zoospores. These spermatozoids escape by the cells breaking across, and have been observed to enter the orifices in the walls of the parent-cells of the spores and effect the fertilization.

Pringsheim has established a number of species, characterized by the form of the sporange and the unicellular or multicellular condition of the antheridial plants, and by the relative dimensions of the organs. We are not assured of the value of these characters, and confine our list to one species.

Rabenhorst describes 16 species.

B. setigera, Ag. (fig. 83), is a common plant, and is variable in the relative length and diameter of its cells, on which ground Kützing has separated a *B. minor*, where the diameter is equal to or greater than the length. Hassall, *Fr. Alg.* pl. 54. figs. 1–4; Dillwyn, *Conferv.* pl. 59.

B. Pringsheimiana, Archer (*Qu. Micr. Jn.* 1866, p. 122).

Bibl. Alex. Braun, *Verjüng. in der Natur* (*Rejuv. &c.*, *Ray Soc.* 1853), *passim*; Hassall, *Ann. Nat. Hist.* xi. 36; *Br. Freshw. Alg.* 209, pl. 54; Decaisne, *Ann. des Sc. Nat.* 2 sér. xvii. 335, pl. 14. fig. 5; Kützing, *Spec. Alg.* 422; Pringsheim, *Berlin Ber.* 1855 (*Ann. Nat. Hist.* ser 2. xv. p. 346; *Qu. Mic. Jn.* iv. p. 131 (1856)); *Jahrb. f. Wiss. Bot.* i. p. 11 (1857); De Bary, *Mus. Senckenberg*, 1856, p. 29; Rabenhorst, *Flor. Alg.* iii. p. 357.

BULBOTRICH'IA, K.—A doubtful genus of Algæ.

Char. Filaments indistinctly jointed, colourless, subcartilaginous, branched; branches bulbous at the base, tumid at the apex, forming sporangia.

B. botryoides. Forming a hoary-green powdery stratum; sporangia green. On roofs.

B. peruana. On rocks.

Bibl. Kützing, *Tab. Phyc.* iv. p. 22; Rabenhorst, *Flor. Alg.* iii. p. 374.

BULIMI'NA, D'Orb.—An important group of Foraminifera, so called from their Bulimine shape, due to an increasing and spiral series of one, two, and even three chambers, close-set, with their apertures towards the umbilical axis. The aperture is an infolded notch of the septal face, and usually oblique. The shell hyaline in the young state, coarser in the adult. Many fossil specimens are arenaceous; these come under *Ataxophragmium*, Reuss. The varieties are infinite, both recent and fossil, and the names numerous. The oldest is found in the Trias. *B. Preslii*, Reuss, is typical. *B. pupoides* (Pl. 18. fig. 46) is a common Atlantic form.

Bibl. D'Orbigny, *For. Fos. Vien.* 61; Williamson, *Brit. Foram.* 61; Carpenter, *Introd. For.* 194.

BUNT.—A disease of Cereal Grasses, &c., depending on Fungi. See Blight, Tilletia.

BURSA'RIA, Ehr.—A genus of Infusoria, of the family Trachelina.

Char. Body ciliated all over; anterior portion projecting beyond the simple edentulous mouth: no tremulous lamina.

Locomotion is effected by cilia usually arranged in longitudinal rows; and somewhat larger ones generally surround the mouth.

Ehrenberg describes fourteen species. They are mostly found in stagnant fresh water; some in the intestines of the frog and *Nais.*

B. vernalis (*Panophrys*, D., *Frontonia*, Cl. & L.) (Pl. 23. fig. 19). Body ovate-oblong, turgid, green, rounded at each end, somewhat narrowed posteriorly, the mouth placed behind the anterior third or fourth of the body; aquatic; length 1-130 to 1-110″.

B. ranarum (*Opalina ran.*) (Pl. 24. fig. 47). Body ovate, lenticular, compressed, large, white, the dorsal and ventral surfaces keeled, anterior part subacute, often truncate posteriorly, mouth inferior, near the anterior pointed end; length 1-210 to 1-70″. In the intestines of the frog.

B. entozoon, Ehr., which is found in the rectum of frogs, is *Balantidium entoz.* of Cl. and Lachm.

The genus *Bursaria* of Dujardin agrees

in part only with that of Ehrenberg. The characters given are :—

Body ciliated, ovoid, usually broader and rounded behind, with a large mouth obliquely situated at the end of a row of larger cilia arranged spirally and commencing at the front end.

It contains six species of Ehrenberg's genus, as well as *Leucophrys patula* and *sanguinea*, *Spirostomum virens* and *Loxodes bursaria* of Ehrenberg.

Cl. and Lachm. characterize the genus *Bursaria* as having a vast funnel-shaped buccal fossa, fringed with cilia, the cavity containing a crest with powerful cirri; and admit 1 species:

B. decora. Body urn-shaped, with a long convolute nucleus, and very numerous contractile vesicles, scattered through the parenchyma. Berlin.

The species of *B.* (Ehr.) are referred to other genera.

Bibl. Ehrenb. *Infus.*; Duj. *Infus.*; Stein, *Die Infus., auf ihr. Entwickel.*; Clap. and Lachm. *Inf.* p. 251.

BURSARI'NA, Duj.—A family of Infusoria.

Char. Body very contractile, of variable form, usually oval, ovoid, or oblong, ciliated all over; a large mouth surrounded by cilia forming a fringe or arranged spirally.

Dujardin recognizes five genera: *Plagiotoma* (*Paramecium compressum*, E.); *Ophryoglena*, E.; *Bursaria*, E. in part); *Spirostomum*, D.; and *Kondylostoma*, D.

Claparède and Lachmann define the family as Ciliated Infusoria, with a patent œsophagus, and a row of buccal cirrhi, forming an arc of a læotropic spiral.

The family is divided thus:

Stentorina (subfamily). A carapace, at least at one period of life; anus anterior.
  Body not truncate in front.
    Buccal spire borne on a narrow process .... *Chætospira.*
    Buccal spire borne on a broad bilobed membranous expansion .... *Freia.*
  Body truncated in front by a broad surface bearing the buccal cirri on its circumference ... *Stentor.*

Bursarina (subfamily) proper. No carapace; anus posterior.
  Watch-glass organ absent.
    No row of cirri within the buccal fossa.
      Front not projecting.
        Body truncated in front by an oblique surface with buccal cirri at its circumference ... *Leucophrys.*
        Body not truncate in front.
          Anterior bundles of cilia absent from buccal fossa.
            No cirri on the right side.
              Body linear .... *Spirostomum.*
              Body not linear .... *Plagiotoma.*
            Bordered with cirri on the right side also.
              Body elongate, of uniform breadth .... *Kondylostoma.*
              Body globular, narrowed in front .... *Balantidium.*
          Buccal fossa very large, with 2 anterior bundles of cilia distinct from the buccal cirri *Lembadium.*
      Fore part projecting beyond the buccal fossa.
          Fossa oblique .... *Metopus.*
          Fossa not oblique .... *Frontonia.*
    Buccal fossa funnel-shaped, with a row of strong cirri .... *Bursaria.*
  A watch-glass-shaped organ at the side of the mouth........ *Ophryoglena.*

Bibl. Duj. *Infus.*; Cl. and Lachm. *Inf.* p. 211.

BUTTERFLIES. See Lepidoptera.

BUXBAUMIA'CEÆ.—A family of operculated Acrocarpous Mosses, of very dwarf stemless habit, arising from a minute tuft of radical filaments (figs. 84, 86, &c.). The leaves are small and flat, composed of few minutish, hexagonal or polygonal parenchymatous cells, empty, destitute of chlorophyl (fig. 86). The capsule (fig. 90), seated on an elongated, thick, fleshy and very scabrous stalk, is more oblique than in any other Mosses, very ventricose on one side, obliquely erect on the other (dorsal) side, cup-shaped at the base, articulated on its stalk, fungoid in general habit, with an obtusely conical straight operculum, and a peristome (fig. 93). Inflorescence monœcious. Brit. genus:

BUXBAU'MIA, Hall.—A genus of Buxbaumiaceæ (Acrocarpous Mosses), represented in Britain by *B. aphylla*, a plant of remarkable character. The annulus, which persists after the operculum has fallen, resembles a third, outer circle of peristomal teeth (fig. 93); the real external peristome is closely applied upon the inner, which forms a truncated cone, slightly twisted when dry. When ripe, the wall of the oblique capsule (fig. 91) gives way at one side, falls off and exposes the spore-sac (fig. 92), which bursts to discharge the spores. The columella (fig. 94) is very large, and the operculum is attached to its summit. The antheridia are oval cellular bodies opening by the separa-

tion of the cells like teeth above, to emit grumous masses of spermatozoids (fig. 85).

B. indusiata has lately been found at Aboyne, in Aberdeenshire, by Prof. Dickie.

BIBL. Bruch and Schimper, *Bryol. Europ.* part i.; Wilson, *Bry. Brit.* p. 198.

Buxbaumia aphylla.

Fig. 84.

Fig. 85.

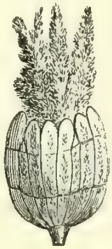


Fig. 86.

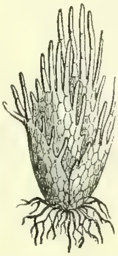


Fig. 84. A male antheridiiferous plant, magnified 40 diameters.

Fig. 85. An antheridium burst and discharging spermatozoids, magnified 100 diameters.

Figs. 86, 87, and 88. Archegoniiferous plant, in different stages, magnified 40 diameters.

Fig. 87.

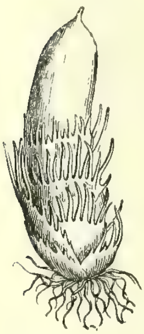


Fig. 88.

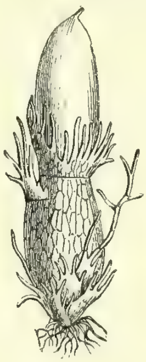


Fig. 89.

Fig. 89. A young fertile plant elevating its sporange covered by the calyptra, magnified 15 diameters.

BYTHOCYTH'ERE, Sars.—A genus of Entomostraca, ord. Ostracoda (sect. Podocopa), fam. Cytheridæ.

Distinguished by the toothed mandibles, the 4-jointed lower, and the 7-jointed upper antennæ.

3 British living species: *B. simplex*, *B. constricta*, and *B. turgida*.

BIBL. Brady, *Linn. Trans.* xxvi. pp. 393, 450.

Buxbaumia aphylla.

Fig. 90.

Fig. 91.

Fig. 92.

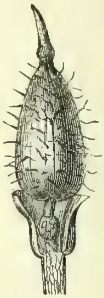


Fig. 90. A ripe capsule, magnified 15 diameters.

Fig. 91. A plant in which the capsule has burst and lost the spore-sac, &c., magnified 15 diameters.

Fig. 92. Spore-sac exposed by removal of the wall of the capsule, showing the filaments by which the spore-sac is suspended within the latter, magnified 40 diameters.

Fig. 93.

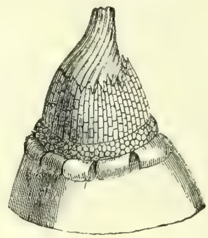


Fig. 94.

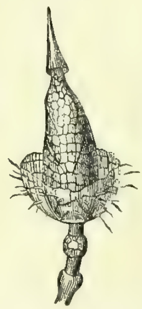


Fig. 93. Mouth of capsule, with double peristome and recurved persistent annulus; magnified 150 diameters.

Fig. 94. Columella with adherent operculum, both capsule-wall and spore-sac having been removed; magnified 60 diameters.

BYTHOT'REPHES, Leydig.—A genus of Entomostraca, ord. Cladocera, fam. Daphniadæ. Allied to *Polyphemus* and *Evadne*.

B. longimanus. Caudal bristle two or three times the length of the body. Found in Scania.

BIBL. Leydig, *Naturg. d. Daphnid.* p. 244; *Ann. Nat. Hist.* 1862, ix. p. 135.

C.

CABEREA, Lamx.—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata, and family契Abereadæ.

Distinguished by the unjointed polypidom, with narrow branches; the cells in two or three rows, with large vibracula (whips) or sessile avicularia at the back, placed obliquely in two rows. One British species:—

C. Hookeri (*Cellularia Hook.*, Johnston). Cells rounded, diverging, and projecting. Rare.

BIBL. Johnston, *Brit. Zooph.* 338; Busk, *Cat. of Mar. Polyz.* 37.

CABE'READÆ.—A family of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata.

Distinguished by the unjointed polypidom, the narrow branches, the cells in two or more rows, with vibracula (whips) or sessile avicularia at the back. Genera:

1. *Caberea.* Back of branches covered with large vibracula.

2. *Amastigia.* Vibracula absent. Not British.

BIBL. Busk (*Brit. Mus.*), *Catal. of Mar. Polyzoa*, 37; Johnston, *Brit. Zooph.*

CABINET for holding microscopic objects. See INTRODUCTION, p. xx.

CACTA'CEÆ.—A singular family of Dicotyledonous plants, especially remarkable, microscopically, for the peculiar structure of their wood-cells. See SPIRAL FIBROUS STRUCTURE, and WOOD.

BIBL. Schleiden, *Beitr. z. Anat. der Cacteen*, St. Petersburg, 184; Miquel, *Ann. des Sc. Nat.* 2 sér. xix. 165.

CA'DIUM, Bail.—A genus of Rhizopoda, fam. Actinophryina ?. Animal unknown.

Char. Shell siliceous (?), ovoid, with a bent beak, and a circular aperture; often with a long curved tapering appendage at the base, and with numerous meridian lines, of which about twelve are visible at once.

C. marinum (Pl. 42. fig. 30). Soundings in the sea of Kamtschatka, and the Gulf-stream.

BIBL. Bailey, *Silliman's Journ.* 1856, xxii. p. 3, pl. 1. f. 2; Wallich, *M. Micr. Journ.* i. p. 107, pl. 3.

CAD'MIUM.—Solution of the oxide or carbonate of this metal in sulphuric acid, when evaporated on a slide, yields disks or circular aggregations of minute radiating needles (circular crystals) of the sulphate, which exhibit essentially the same phenomena under the action of polarized light, as those of the oxalurate of ammonia. The disks frequently exhibit irregular undulating somewhat concentric dark bands, indicating parts where no double refraction takes place.

Pl. 31. fig. 10 gives but a very imperfect idea of the appearances presented by these crystals, when viewed by polarized light.

CÆOMA'CEI. See UREDINEI and USTILAGINEI.

CALCARI'NA, D'Orb.—One of the Rotaline *Foraminifera*; asymmetrically helicoid, with three or more whorls of chambers; coated with exogenous shell-growth, as granules, spines, and stick-like processes. Shell thick, with the vascular and supplementary skeleton. Common in the Chalk of Maestricht, and in several Tertiary strata; and living abundantly in the Mediterranean and other warm seas.

C. Spengleri (Pl. 47. fig. 27).

BIBL. Reuss, *Sitz. Ak. Wiss. Wien*, xliv. 315, 1861; Carpenter, *Foram.* 1862, 216, &c.

CALCIUM, CHLORIDE OF.—This salt may be prepared by adding excess of prepared chalk to dilute muriatic acid, boiling and filtering the solution, and then evaporating it to dryness. The crystals belong to the rhombohedric system, and are deliquescent.

An aqueous solution of chloride of calcium is of great service in microscopic researches, as objects which have been immersed in or moistened with it do not become dry at ordinary temperatures. Hence, if a drop of the solution be added to an object covered with thin glass, and excluded from dust, it may be preserved without the use of a cement to enclose it in a cell (see PRESERVATION). Its use in determining the presence of cell-membranes has been already alluded to (INTRODUCTION, p. xxxvi. § 4). When employed for this purpose, its action must always be controlled by the action of water, crushing, &c.

The strength of the solution may be about one part of salt to two of water, or a saturated solution may be used; it should be kept in one of the test-bottles (INTROD. p. xxiv), with a lump of camphor floating on its surface.

It frequently happens that the solution in which objects have been immersed (on a slide) exhibits crystals. These usually consist of either the chloride itself, the sulphate or the phosphate of lime, the two latter

formed from the alkaline salts derived from the object.

CALCULI. See CONCRETIONS.

CALEP'TERYX, Linn.—A genus of Neuropterous Insects, belonging to the family LIBELLULIDÆ.

CALIA, Werneck.—A doubtful genus of Infusoria.

Char. Monads included in jelly (*Pandorinæ*) fixed to aquatic plants, not swimming free. Two species.

BIBL. Werneck, *Ber. d. Berl. Akad.* 1841, p. 377.

CALICIEÆ.—A family of Gymnocarpous Lichens, characterized by their circular or globular, more or less stalked apothecia, furnished with special excipulum and filled with a compact pulverulent mass. Br. genus CALICIUM.

CALI'CIUM, Ach.—A genus of Calicieæ (Gymnocarpous Lichens), containing a large number of species, growing upon bark, old palings or epiphytically on other Lichens (*C. sessile*). The spermatia, produced in the spermogonia, are stick-shaped and curved; the spores are double, and six or eight exist in each long tubular theca.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 142; *Engl. Botany*, pls. 810, 1832, 2520, &c.; Tulasne, *Ann. des Sc. Nat.* 3 sér. xvii. 209, pl. 15. figs. 15–20; Leighton, *Lichen Flora G. B.* p. 39; Lindsay, *Lichens*, p. 257.

CA'LIGUS, Müller.—A genus of Crustacea, of the order Siphonostoma, and family Caligina (*Caligidæ*).

Char. Head in the form of a large buckler, having anteriorly large frontal plates, which are furnished with a small suctorial disk or lunule on the under surface of each lateral portion; antennæ small, flat and two-jointed. Thorax with only two distinct articulations, thoracic segments uncovered; second pair of jaw-feet two-jointed and not in the form of a suctorial disk. Legs four pairs with long plumose hairs, fourth pair slender, of only one branch and serving for walking.

Four species. Found upon the brill, cod, mackerel, plaice, trout, &c.; length 1-5 to 1″.

BIBL. Baird, *Brit. Entomos.* pp. 256, 269.

CALLIDI'NA, Ehr.—A genus of Rotatoria, of the family Philodinæa.

Char. Eye-spots absent; a proboscis and a foot with horn-like processes.

The rotatory organ is double, but not furnished with a stalk; proboscis also ciliated; foot elongate, forked, and with four accessory horn-like processes, hence with six points altogether; teeth small and numerous (two only in each jaw in one species, Gosse). Aquatic.

1. *C. elegans*, Ehr. (Pl. 34. fig. 10). Crystalline; length 1-70″. (Pl. 34. fig. 11, jaws.)

2. *C. rediviva*, Ehr. Granular or fleshy, ova red; length 1-70″.

3. *C. bidens*, Gosse. Teeth two in each jaw; length 1-45″.

4. *C. constricta*, Duj. Rotatory organ constricted; length 1-50″.

5. *C. parasitica*, Gig. On *Gammarus* and *Asellus*.

BIBL. Ehrenb. *Infus.* p. 482; Dujardin, *Infus.* p. 655; Pritchard, *Infus.* p. 701; Gosse, *Ann. Nat. Hist.* 1851. viii. p. 202; Giglioli, *Qu. Mic. Journ.* 1863, p. 237.

CALLITHAM'NION, Lyngb.—A genus of Ceramiaceæ (Florideous Algæ), containing a large number of species, some common, many rare. In the smaller species the structure is very simple, the branched feathery fronds being composed of single rows of tubular cells; in the larger species the stem and larger branches are strengthened by external filaments, which grow over the original axis, apparently originating at the base of the upper branches and growing down (somewhat as in *Batrachospermum*). Antheridia have been observed in *C. Borreri* and *C. corymbosum*, collected in tufts on the ultimate branches. The *favellæ* are naked, and the tetraspores are tetrahedrally arranged.

BIBL. Harvey, *Br. Mar. Algæ*, pl. 23 A.; *Phyc. Brit.* pls. 159, 272, 230, &c.; Thuret, *Ann. des Sc. Nat.* 3 sér. xvi. p. 16, pl. 4; Nägeli, *Algen-Systeme*, 198, pl. 6.

CALO'CERA. — A genus of Clavariei (Hymenomycetous Fungi) differing from Clavaria in the subcartilaginous texture and viscid hymenium; the structure moreover approaches that of Tremellini. *C. viscosa*, which occurs on decayed pine stumps, is one of our most beautiful Fungi. Three or four more species occur in this country.

BIBL. Berk. *Outl.* p. 284.

CALODISCUS, Rabenhorst.—*C. superbus* = *Campylodiscus*, *sup.*

CA'LOTHRIX, Ag.—A genus of Oscillatorieæ (Confervoid Algæ), growing in tufts, the filaments forming a branched frond by lying in apposition and being concreted by their sheaths here and there. *C. mirabilis*, Ag. (Pl. 4. fig. 22), is a rare freshwater species in England, found on mosses in small streams, æruginous green,

growing blackish. Diameter of the filaments about 1-1200 to 1-1800″. According to Hassall, *C. atroviridis*, Harv., is not distinct.

Fig. 95.

Calothrix Tomasiniana. Fragment of a filament. Magnified 300 diams.

Fig. 95 illustrates the close annulations on the filaments of this genus; the nature of this annulated structure will be treated more particularly under the head of OSCILLATORIACEÆ.

BIBL. Hassall, *Freshw. Algæ*, 243, pl. 69. 1; Kützing, *Tab. Phyc.* cent. ii. pl. 29. ii.; Dillwyn, *Brit. Confervæ* (*C. mirabilis*), pl. 96.

CALYCEL'LA, Hincks.—A genus of marine Polypi, of the order Hydroida, and family Lafoëidæ.

Char. Stem creeping, simple, or erect, compound and branched; cells tubular, with an operculum formed of convergent segments or a plaited membrane; polypes cylindrical, with a conical proboscis.

C. syringa=*Campanularia syr.* Very common on sea-weeds, &c.

C. fastigiata.

BIBL. Hincks, *Brit. Zooph.* p. 205.

CALYMPERACEÆ.—A tribe of Pottioid Mosses, containing one British genus:

Fig. 96.

Fig. 98.

Fig. 97.

Fig. 96. Encalypta vulgaris. Peristome.
Fig. 97. E. ciliata. Calyptra.
Fig. 98. E. streptocarpa. Fragment of peristome.

1. *Encalypta.* Calyptra long, cylindrically bell-shaped, narrow above on account of the clavellate operculum, surpassing the capsule, firm, entire, torn or ciliated below (fig. 97). Peristome absent, simple (fig. 96), or double (fig. 98). External: sixteen lanceolate or long-subulate, ciliiform teeth, mostly with a longitudinal line, reddish, rugulose. Internal: a delicate membrane agglutinate to the teeth, produced into cilia opposite or alternating with the teeth.

CALYPOGE'IA, Raddi.—A genus of Jungermannieæ (Hepaticæ), founded on *Jungermannia Trichomanis*, Dicks. The leaves have a peculiar glaucous hue; the sporange is spirally twisted. Gemmæ are produced at the extremities of leafless prolongations of the stem.

BIBL. Hooker, *Brit. Jungerman.* pl. 79; *Eng. Botany*, 1728.

CAM'BIUM.—The name applied to the young cellular layers from which the woody structures of plants are developed. When we make sections near the growing points of any stems, as in terminal or axillary buds, we find a quantity of extremely delicate, slender, elongated cells, distinguished from the generally rounded cells of the parenchyma, and forming rudimentary cords in the situation of the future woody and vascular bundles. In the Dicotyledons, they stand in a circle, so as to separate the pith from the young bark; the ring may be seen in cross sections a little below the growing point. At the very apex of the stem all the tissues merge into the delicate universal generative tissue. In the apex of Monocotyledonous stems, and also those of Ferns and the higher Flowerless plants, the cambium is found in delicate cords imbedded in the nascent general parenchyma, indicating, even in this early condition, the position and arrangement of the isolated fibrous and vascular bundles. Sections of the outer region of the stem of Dicotyledons demonstrate the existence of a layer of cambium at the outer surface of the youngest wood, which indeed passes gradually into the cambium. This cambium is the tissue from which the succeeding layers of wood are generated; and its position on the *outside* of the fibro-vascular bundles gives these their indefinite power of development. The cambium of the Monocotyledonous bundles becomes enclosed between the wood and vessels of individual bundles, so that their growth is limited. The cambium of the outside of the wood of Dicotyledons forms

new layers of liber, in most cases, on the inside of the old ones, *pari passu* with the development of the layers of wood. Cambium, which is in great part only an early and transitional form of cellular tissue, afterwards to become developed into wood, is composed of delicate cellulose cells enclosing a primordial utricle, nucleus, and abundance of nitrogenous protoplasm, but usually without chlorophyl. The cells multiply by transverse subdivision in the elongation of the stem, and by perpendicular division (tangential and radial) as the stem expands in diameter. This process is effected by the constriction of the primordial utricle and gradual development of a septum, as in ordinary vegetative cell-development. The cambium of most Dicotyledons is gradually matured into wood from within outwards; but in the Monocotyledons and Flowerless Cormophytes it often remains in great part in a delicate and soft condition, forming what are called by Von Mohl the *vasa propria*, or proper vessels. Owing to the delicacy of its structure, cambium was formerly imagined to be a thick mucilaginous fluid poured out in the growing regions of plants (as between the wood and liber of Dicotyledonous stems in spring), which by degrees become organized and converted into cellular tissue, by the independent origin and subsequent coalescence of a number of cells generated in this fluid. This view, founded on imperfect observation, was strongly supported by Mirbel and others.

Bibl. Treviranus, *Phys. der Gewächse*, i. 159; Mirbel, *Ann. des Sc. Nat.* 2 sér. xi. 321, and 2 sér. xix. 197; Payen, *Compt. Rendus*, 1839, 509; Schleiden, *Grundzüge d. Botanik* (*Principles of Botany*); Henfrey, *Element. Course of Botany*; Nägeli, *Zeitsch. für wiss. Botanik*, iii. 64; Mohl, *Die vegetab. Zelle* (*Vegetable Cell*, Transl. London, 1853); Schacht, *Die Pflanzenzelle*, Berlin, 1852.

CAMBRIC.—This name was formerly applied strictly to the finest kind of *linen* cloth. It is used now in a loose sense in trade. French cambric, however, ought to be linen. Scotch and English cambrics are commonly made of cotton, while Indian cambric is made of the grass-cloth fibre. The fibres may be distinguished under the microscope, and the value of the fabric thus ascertained. See Fibrous Substances and Cotton.

CAMERA LUCIDA. Introduction, p. xix.

CAMPANULA'RIA, Lamk.—A genus of Polypi, of the order Hydroida, and family Campanulariadæ.

Distinguished by the creeping or erect polypidom, the filiform continuous main tube, giving off its stalked and campanulate cells irregularly or in whorls, the usually long, ringed stalks, and the scattered, sessile vesicles.

11 British species (Johnst.). In nine the stem is a single tube; in two it consists of several parallel tubes.

1. *C. volubilis* (Pl. 33. fig. 4). Stem a single tube, creeping, filiform; cells on long, slender ringed stalks, campanulate, with a serrated margin; vesicles ovate, wrinkled concentrically. Parasitic on sea-weeds &c.; frequent. It forms an elegant microscopic object.

2. *C. dumosa.* Stem compound, erect or climbing, irregularly branched; cells long, tubular, patent, almost sessile, orifice entire. In deep water.

Hincks defines the genus thus:—Stems simple or branched; cells bell-shaped and hyaline, without operculum; polypes with a large cup-shaped proboscis; germ-cells borne on the stems or the creeping stolon, with fixed spore-sacs. 13 species; 3 doubtful.

Bibl. Johnston, *Brit. Zooph.* 107; Gosse, *Mar. Zool.* i. 24; Hincks, *Brit. Zooph.* p. 160.

CAMPANULAR'IADÆ, Johnst.—A family of marine Polypi, order Hydroida.

Char. Those of Sertulariadæ, but cells stalked.

Genera: *Campanularia, Laomedia.*

Hincks revises the family thus:—Cells terminal, stalked, campanulate; polypes with a large trumpet-shaped proboscis. And he admits the genera *Clytia, Obelia, Campanularia, Lovenella, Thaumantias,* and *Gonothyræa.*

Bibl. Johnston, *Brit. Zooph.*; Gosse, *Mar. Zool.* i.; Hincks, *Brit. Zooph.* p. 137.

CAMPANULI'NA, Van Beneden.—A genus of marine Polypi, order Hydroida, family Campanulinidæ.

Char. Stem simple or branched, rooted; cells pointed above; polypes cylindrical, with webbed tentacles; reproduction by free medusa-buds, single in each capsule. 3 species.

Bibl. Hincks, *Brit. Zooph.* p. 186.

CAMPANULI'NIDÆ.—A genus of Polypi, order Hydroida.

Char. Cells ovato-conic, stalked; polypes long, cylindrical, with a small conical proboscis.

Genera: *Campanulina, Zygodactyla, Opercularella.*

CAM'PIUM, Presl.—A genus of Acrosticheæ (Polypodiæous Ferns). Exotic.

CAMPTOCER'CUS, Baird (*Lynceus*, Müll. in part). A genus of Entomostraca, of the order Cladocera, and family Lynceidæ.

Char. Carapace ovoid; beak blunt, directed forwards or slightly downwards; abdomen long, slender, tail-like, extremely flexible and serrated. 1 species:

C. macrourus (Pl. 15. fig. 4). Carapace striated longitudinally, slightly sinuated and ciliated on the anterior margin; beak rather blunt; aquatic.

BIBL. Baird, *Brit. Entom.* p. 128.

CAMPTOSU'RUS, Presl.—A genus of Asplenieæ (Polypodiæous Ferns). Exotic.

CAMPTOTHE'CIUM, Br. & Sch. = *Hypnum* in part.

CAMP'TOUM, Link.—A genus of Dematiei (Hyphomycetous Fungi), allied to *Arthrinium*. *C. curvatum*, Lk. (*Arthrinium curvatum*, Kze.) grows in tufts of very slender filaments, bearing very minute, curved spores, upon *Scirpus sylvaticus.*

BIBL. Berk. and Br. *Ann. Nat. Hist.* 2 ser. viii. 100; Fries, *Syst. Myc.* iii. 377; Corda, *Ic. Fung.* iii. pl. 1. fig. 17.

CAMPYLODIS'CUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, free, disk-shaped; disk curved or twisted (saddle-shaped); furnished with mostly radiate markings, which are frequently interrupted. Aquatic and marine.

The Rev. Mr. Smith terms the markings costæ or canaliculi, and interprets them to be minute canals forming means of communication between the internal cell-membrane and the surrounding fluid.

Smith describes 9 species (British), Kützing 12 others.

C. costatus, Smith (Pl. 12. fig. 16). Valves circular; radii 30–40, extending about halfway to the centre, which is minutely punctate; diameter 1-270″; aquatic.

C. spiralis, Smith. Outline of front view resembling a figure of 8; valves elliptical; radii about 60, nearly parallel and transverse; length 1-160″; aquatic.

C. clypeus, Ehr. (Pl. 19. fig. 18). Valves suborbicular, exhibiting a circular and a median transverse hyaline line; radii broad, interrupted in the middle, which is punctate; length 1-200″; aquatic and fossil.

Rabenhorst describes 28 European species, and enumerates 27 foreign and fossil species.

BIBL. Smith, *Brit. Diat.*; Kützing, *Bacill.* and *Sp. Alg.*; Rabenhorst, *Flor. Alg.* i. 45; Grun, *Wien. Verhandl.* 1862.

CAMPYLONE'IS, Grun.—A genus of Diatomaceæ, family Entopyleæ.

Char. Frustules scutelliform, adnate, transversely arcuate; valves heterogeneous—the inferior costate, the superior cribroso-punctate; nodules absent.

C. Argus. Atlantic.

BIBL. Grun, *Wien. Verhandl.* 1862, 429.

CAM'PYLOPUS, Brid. (MUSCI) = DICRANUM.

BIBL. Wilson, *Bryol. Brit.* p. 87.

CAM'PYLOPUS, Cl. and Lachm.—A genus of marine Infusoria, family Oxytrichina.

C. paradoxus (Pl. 42. fig. 29). With six posterior setæ, and eight posterior feet, six on the right and two on the left side. Remarkable for its bounding leaps, which make it very difficult of observation.

BIBL. Claparède and Lachmann, *Infus.* p. 184.

CAMPYLOSTE'LIUM, Br. and Sch.—A genus of Leptotrichaceous Mosses, including some *Dicrana* and *Grimmiæ* of older authors.

BIBL. Wilson, *Bryol. Brit.* p. 51.

CAMPYLOS'TYLUS, Shadb.—A genus of Diatomaceæ: = *Synedra*, sp.

BIBL. Greville, *Qu. Mic. Journ.* 1862, p. 232.

CANADA BALSAM. See BALSAM.

CANALICULI. See BONE.

CANCER.—We have thought it best to include the consideration of cancer in that of tumours. See TUMOURS.

CANCROID. See TUMOURS, Cancroid.

CANDA, Lamx. (*Cellularia* part, Johnston).—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Cyclostomata, and family Cellulariadæ.

Distinguished by the jointed, branched, erect polypidom, the flat, linear branches with the cells on one plane, and the cells having a vibraculum in a notch on the outer side but no avicularium at the upper angle.

C. reptans (*Cellularia rept.*, Johnston) (Pl. 33. figs. 5, 5 *d* and 5 *c*). Orifice oval, with 3 or 4 marginal spines, and a stalked operculum with a lobed lamina. Common.

BIBL. Johnston, *Brit. Zooph.*; Busk (*Brit. Mus.*), *Catal. of Mar. Polyzoa*, 26.

CANDEI'NA, D'Orb.—A modification of the Textularian type of *Foraminifera*; being Verneuiline (that is, built up with a three-sided alternation), and having a row

of pseudopodial pores along the base of its last chamber.

BIBL. D'Orbigny, *For. Foss. Vien.* 193, pl. 21. f. 28; Carpenter, *Introd. Foram.* 192.

CANDONA, Baird (*Cypris*, in part Müll.).—A genus of Entomostraca, of the order Ostracoda, and family Cypridæ.

Char. Two pairs of antennæ; superior long, with numerous joints and a pencil of long filaments; inferior stout and pediform, without a tuft of long hairs or filaments (see CYPRIS); eye single; motion creeping only. Five British species; aquatic.

C. albicans, Br.; *lactea*, Bd.; *compressa*, Koch; *candida*, Müll.; and *detecta*, Müll.

BIBL. Baird, *Brit. Entomostr.* p. 159; Norman, *Ann. Nat. Hist.* 1862, ix. p. 46; Brady, *Linn. Trans.* 1868, xxvi. p. 381.

CANNA.—A genus of Monocotyledonous plants belonging to the same natural family as the arrow-root (Marantaceæ), and valuable from the same cause. *Tous-les-mois* is a starch derived from the tubers of a *Canna*, supposed to be *C. edulis*, Ker. The grains of genuine *Tous-les-mois* have distinctive microscopic characters, as shown in Pl. 36. fig. 25, which is taken from a specimen in the Kew Museum.

CANTHAREL'LUS.—A genus of Agaricini (Hymenomycetous Fungi), differing from *Agaricus* in the vein-like gills. The most important species is *C. cibarius*, which is a frequent article of food on the continent, though in general but little esteemed in this country. It is of a beautiful egg-yellow tint, and has a very fragrant perfume. Several other species occur in this country.

BIBL. Fries, *Ep.*; Berk. *Outl.* p. 215.

CANTHOCAMPTUS, Baird (*Cyclops*, pt., Müll.).—A genus of Entomostraca, of the order Copepoda, and family Cyclopidæ.

Char. Jaw-feet small, simple; inferior antennæ simple; ovary single.

Four species; one aquatic, three marine.

C. minutus (Pl. 15. fig. 6). Thorax and abdomen not distinctly separate, consisting of ten segments, successively diminishing in size, the last terminating in two short lobes, from which issue two long filaments, slightly serrate on their edges; antennæ short, seven-jointed in the male, nine in the female; inferior antennæ simple, two-jointed, the first joint with a small lateral joint, terminated by four setæ; feet five pairs.

Common in ditches; colour reddish; length about 1-15″. (Pl. 15. fig. 6: *a*, inferior antenna; *b*, first pair of jaw-feet; *c*, second pair.)

C. cryptorum, n. sp., Brady. In a coal-mine.

BIBL. Baird, *Brit. Entom.*; Brady, *Qu. M. Jn.* 1869, p. 23.

CAOUTCHOUC.—A gum-resinous substance contained in the milky juices of many plants, but most abundantly in those of the families Euphorbiaceæ, Urticaceæ and Apocynaceæ, whence the India-rubber of commerce is obtained. The caoutchouc appears in the form of minute globules suspended in a watery fluid containing a gummy substance, so that the milky juice may be regarded as a kind of emulsion. For further details, see LATEX.

CAPILLARIES.—The minute vessels which the blood traverses in passing from the arteries to the veins.

Fig. 99.

Magnified 300 diameters.

One of the smallest vessels from the arterial side. 1, smallest artery; 2, transition vessel; 3, large capillaries; 4, small capillary. *a*, structureless membrane with few nuclei, representing the adventitious coat; *b*, nuclei of the muscular fibre-cells; *c*, nucleus inside the small artery; *d*, nuclei of the capillaries and intermediate vessel. From the human brain.

The capillaries appear to consist of a deli-

cate, transparent, tolerably resisting and elastic membrane, and a number of oval or rounded longitudinal nuclei; but when treated with very dilute solution of nitrate of silver, the-dark dyed outlines of epithelial cells, to which the nuclei belong, are brought to light (Pl. 42. fig. 31). The diameter of the human capillaries varies from 1-5000 to 1-1000″, the most common being perhaps 1-3000″. The size of the capillaries in the Vertebrata generally, bears a relation to the size of the coloured corpuscles of the blood. Thus they are largest in Birds, Fishes and Reptiles. The larger capillaries have thicker walls and more numerous nuclei than the smaller ones.

The capillaries branch and anastomose freely, giving rise to the beautiful networks so well known as favourite microscopic objects when injected.

The most important pathological change which the capillaries undergo is that of Fatty Degeneration. The general arrangement of the capillaries is best seen in injected preparations (Injection). Their structure may be examined in minute pieces of well-washed brain, or of the retina; a minute portion of washed lung will answer the purpose well. These should be dissected with the mounted needles. The relation of the capillaries to the surrounding minute structures may be shown in portions of tissue which have been imperfectly injected, or injected with a liquid containing a small quantity only of colouring-matter; in these the capillaries may be recognized by their containing the scattered granules of the colouring-matter. Acetic acid is frequently of use in rendering the tissue transparent and bringing the nuclei to light.

See Vessels and Circulation.

Bibl. Paget, *Report, &c., Brit. and For. Med. Rev.* 1842, xiv.; Kölliker, *Mikr. Anat.* Bd. ii.; Henle, *Allgemein. Anat.*; Wedl, *Grundzüge d. path. Hist.*; Frey, *Histologie, &c.*

CAPNODIUM, Montagne.—A genus of Perisporiacei (Ascomycetous Fungi) growing as a kind of mildew on leaves and shoots, forming a blackish flocculent coat composed of short, branched, beaded or moniliform filaments, densely interwoven. The perithecia arise vertically from this, and are either simple or branched, at first simple sacs, but probably afterwards thickened by a layer of cells; a number of threads ultimately grow up from the mycelium, partially cover the central sac, and, closely crowded, some of their tips project beyond it, forming a fringe; the cells of this fringe readily become detached and appear to reproduce as *conidia.* The central sac contains largish delicate asci, probably often absorbed at an early period so as to set the spores free in the cavity.

Particular joints of the filaments sometimes become *pycnidia*, producing free spores in their interior, without asci.

Three species seem to occur in Britain:—

1. *C. elongatum*, Berk. & Desm. On pear-leaves.

2. *C.* (*Fumago*) *quercinum*, Pers., grows on oak-leaves.

3. *C.* (*Fumago*) *Footii*, Berk. & Desm., on evergreens, on the birch-tree, and on *Mercurialis perennis.*

Bibl. Berkeley, *Crypt. Bot.* p. 275; Berk. & Broome, *Ann. Nat. Hist.* 2nd ser. xiii. p. 468; Berk. & Desmazières, *Journal Hort. Soc.* iv. 243; Montagne, *Ann. Nat. Hist.* 2nd ser. iii. p. 520.

CAPSOSIRA, K.—A genus of Rivularieæ.

Char. Filaments erect, narrow, crowded, parallel, moniliform, sheathed; cells thick-walled.

C. Brebissonii. Greenish black. On stones, in streams (France).

Bibl. Kützing, *Sp. Alg.* 344.

CARAPACE, or lorica.—A term somewhat indefinitely applied to the whole or a part of the shell or outer coat of certain animals—as those belonging to the classes Crustacea, Rotatoria, Infusoria, &c.

In regard to the Rotatoria and Infusoria, it has been divided into:—the *testa* or *testula*, an envelope resembling that of the tortoise, within which the body of the animal is enclosed, the head and the tail being free—as in the genera *Brachionus, Monura, Colurus*, &c.; the *scutellum*, a round or oval envelope, covering only the back of the animal, in the manner of a buckler; and the *urceolus*, a membranous or firm envelope, sometimes gelatinous, in the form of a bell or cylinder, open at one end and closed at the other, and within which the animal can completely retract itself—as in Difflugia, &c.

Ehrenberg extended the use of this term also to the external envelope of *Volvox, Gonium*, and the Diatomaceæ. As these have been removed to the vegetable kingdom, it is not now applied to them.

CARBA'SEA, Gray.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Flustradæ.

Distinguished by the expanded, leafy,

flexible, erect polypidoms; and the cells being arranged in many rows, on one side only.

C. papyrea (*Flustra carbasea*, Johnst.) (Pl. 33. figs. 19, 20). Cells oblong, narrowed and truncate below, convex, unarmed. Deep waters.

BIBL. Johnston, *Brit. Zooph.* 345; Busk, *Cat. of Marine Polyzoa*, 50.

CARBONATE OF LIME. See LIME, Carbonate of.

CARBO'NIA, Jones.—A genus of small Cypridiform *Entomostraca*, found in the Carboniferous strata, and distinguished chiefly by their peculiar muscle-spot.

BIBL. T. R. Jones, *Geol. Mag.* iii. 218, pl. 9. f. 4–10.

CARBONIC ACID.—The presence of this gaseous acid is usually determined by the addition of another acid, as acetic or muriatic, to the object under the microscope; and if colourless and inodorous bubbles escape, it is concluded, and in most cases correctly, that carbonic acid is present.

It must be borne in mind that if the object be immersed in liquid, the gas may arise either from this or the object; for it is well known that the escape of a gas from a liquid charged with it is greatly facilitated by the presence of a solid and especially a pointed body, and that the gas escapes from the liquid at its surface or point; thus the false appearance is produced of the gas being liberated from the body. Hence the importance of washing the object before the addition of the acid (INTRODUCTION, p. xxxviii).

When crystalline bodies of different forms are present, these must be separated before the addition of the acid, otherwise the bubbles liberated from those of one kind, by escaping at the surface of the others, may give rise to the false conclusion that they were derived from the former.

Recollection of the fact that carbonic acid is readily absorbed by solution of potash, would allow of the distinction of bubbles of this acid from those of air.

BIBL. See CHEMISTRY.

CARCHE'SIUM, Ehr.—A genus of Infusoria, belonging to the family Vorticellina.

Char. Pedicle branched, spirally flexible; bodies of the animals all alike (=branched *Vorticellæ*).

C. polypinum (Pl. 23. figs. 20, 21). Bodies conico-campanulate, colourless, broad and truncate in front, margin prominent, pedicle subumbellate; aquatic; length of bodies 1-586 to 1-430″.

Ehrenberg describes two other species, *C. pygmæum* and *C. spectabile.*

Claparède and Lachmann define *Carchesium* as Vorticellina forming branched colonies in which each individual is furnished with a separate peduncular muscle,—admitting 3 species:

C. polypinum. Campanulate, expanded in front; cuticle smooth; nucleus recurved in a longitudinal plane; peduncle not jointed.

C. spectabile. Thimble-shaped, not expanded; cuticle finely striated; nucleus recurved in a longitudinal plane, with several sinuosities; peduncle not jointed.

C. epistylis. Body very narrow, smooth; nucleus curved in a transverse plane; peduncle distinctly jointed.

BIBL. Ehrenb. *Infus.* and *Ber. d. Berl. Akad.* 1840, p. 199; Dujardin, *Infus.* p. 551; Stein, *Infusionsthiere*, p. 48, &c.; Clap. and Lachm. *Inf.* p. 97.

CA'RIS, Latreille.—A doubtful genus of Arachnida, of the order Acarina, and family Gamasea.

C. vespertilionis is found upon the bat (*Vespertilio pipistrellus*). It is probably a young *Dermanyssus.*

BIBL. Latreille, *Gen. Crustac. et Insect.* i. p. 161; Audouin, *Ann. d. Sc. Nat. Zool.* xxv. p. 412; Walckenaer, *Aptères* (*Gervais*), p. 227.

CARMINE.—This beautiful pigment is sometimes used to feed Infusoria and fill their sacculi or gastric spaces (INFUSORIA).

It is also used as a colouring-matter for injections and for dyeing the tissues (see DYEING).

CAR'PAIS. See GAMASUS.

CARPENTE'RIA, Gray.—A genus of Foraminifera allied to *Globigerina*, but ceasing at an early age to grow spirally, and then forming expanded tent-like chambers which enclose the first-formed cells; attached by the base to shells or corals, and with a crater-like common aperture at the apex. Siliceous spicules occur in the cells.

C. balaniformis. (Pl. 42. fig. 28.)

BIBL. Carpenter, *Introd. Foram.* 186.

CARPOMI'TRA, Kütz.—A genus of Sporochnaceæ (Fucoid Algæ) containing one rare British species, *C. Cabreræ*, Clem., remarkable for the peculiar mitre-shaped conceptacle containing the spores.

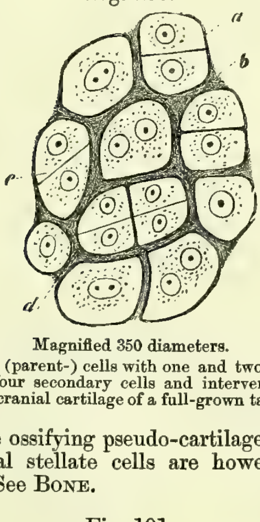
BIBL. Harvey, *Br. Marine Alg.* pl. 5 B., *Phyc. Brit.* pl. 14.

CARTILAGE.—Cartilage consists of a firm, but elastic, bluish, milky or yellowish substance, which morphologically forms

either a simple parenchyma composed of cells, or a structure consisting of cells immersed in an intermediate basis, probably also of original cell-structure.

The cells of cartilage are usually round, oval, elongated or angular, frequently flattened and sometimes spindle-shaped. In some cartilage they appear stellate, as in that of the cuttle-fish, the sharks and rays, and enchondromatous growths; but it has not been determined in these instances whether they are really stellate, or whether the stellate appearance arises from the existence of secondary deposit within cartilage-cells of the common forms.

Fig. 100.

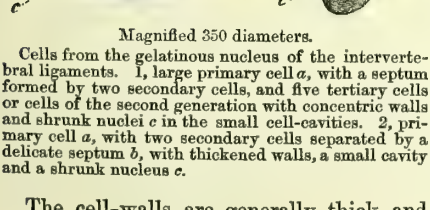


Magnified 350 diameters.

Primary (parent-) cells with one and two nuclei, or two and four secondary cells and intervening basis. From the cranial cartilage of a full-grown tadpole.

In the ossifying pseudo-cartilage of true bone, real stellate cells are however met with. See BONE.

Fig. 101.



Magnified 350 diameters.

Cells from the gelatinous nucleus of the intervertebral ligaments. 1, large primary cell *a*, with a septum formed by two secondary cells, and five tertiary cells or cells of the second generation with concentric walls and shrunk nuclei *c* in the small cell-cavities. 2, primary cell *a*, with two secondary cells separated by a delicate septum *b*, with thickened walls, a small cavity and a shrunk nucleus *c*.

The cell-walls are generally thick, and frequently composed of several layers. The contents consist of a clear liquid and a nucleus; sometimes the cell and sometimes both the cell and the nucleus contain one or more globules of oil. The cells also frequently constitute parent-cells, *i. e.* cells containing other or secondary cells within them, these containing also nuclei or tertiary cells.

The secondary and tertiary cells sometimes exhibit well the internal layers.

The intervening basis, when present, is either homogeneous, finely granular, or fibrous; sometimes the fibres are distinct and can be isolated. The simplest form of cartilage, viz. that composed of cells only, is met with in the *chorda dorsalis* of embryos, in the adult skeleton of many fishes, and in the cartilage of the ear of many mammals. It is beautifully seen in the *chorda dorsalis* of a young tadpole or young *Triton*, or in the ear of the mouse (Pl. 40. fig. 38). In the latter instance, each cell is filled with a globule of oil, which must be separated by digestion in ether before the cell-structure can be properly examined; but boiling on a slide in solution of potash, or the addition of sulphuric acid will liberate the globules of fat from parts of a section. This variety of cartilage exactly resembles in appearance a section of vegetable cellular tissue.

The second variety of cartilage, in which the basis is homogeneous or finely granular (yet of cellular origin), or true cartilage as it is called (Pl. 40. fig. 39), is met with in the larger cartilages of the respiratory organs, in the articular, costal, ensiform and nasal cartilages. In this the cell-walls are closely adherent to the intercellular basis, so that they are rarely visible without the use of reagents. The cells are most numerous in the articular cartilages, and are mostly smaller the further they are from the bone. Their long axes are placed perpendicularly to the axis of the bone, except in a thin layer next the surface of the joints, in which they are parallel to the surface.

The third variety of cartilage or fibro-cartilage (Pl. 40. fig. 40) occurs in the human epiglottis, the external ear, the Eustachian tube, the intervertebral ligament, &c. It consists principally of fibres, single or in bundles, sometimes running parallel, at others interlacing, and between them lie the cartilage corpuscles. Sometimes the basis of true cartilage becomes fibrous, and true fibres may be found in it. The chemical composition

of the components of cartilage has not been satisfactorily determined. The homogeneous basis usually consists of chondrine. The cell-walls are composed of a substance allied to elastic tissue; they are not dissolved by boiling in water, and are acted upon with difficulty by acids and alkalies. The liquid within the cells is probably albuminous; it is coagulated by water and dilute organic acids, and is readily soluble in alkalies. The fibrous elements of the fibro-cartilages sometimes agree in composition with white fibrous tissue, at others with the yellow or elastic tissue.

When sections of cartilage are subjected to the action of Schultze's test, the cells are coloured red, but not the basis.

The only instance of cartilage occurring in the Invertebrata, is found in the Cephalopoda (*Sepia*).

For an account of the minute anatomy of cartilage in disease, we must refer to the valuable papers of Dr. Redfern in the Edinburgh Monthly Journal for 1849, 1850, and 1851. See also ENCHONDROMA.

BIBL. Kölliker, *Mik. Anat.* Bd. i.; Paget, *Brit. and For. Med. Rev.* 1842, xiv.; Henle, *Allg. Anat.*; Redfern, *Ed. Month. Journ.* 1854; Mulder (and Donders), *Physiol. Chemie*; Frey, *Histol.* p. 172; Bubnoff, *Ber. d. Wien. Akad.* lvii. (*M. Micr. Journ.* 1869, p. 127).

CASEINE is the proteine constituent of milk. It possesses no microscopic characters.

Some years since, a tumbler containing porter, at the bottom of which was a small quantity of a whitish sediment, was brought to us for examination, suspicion being entertained that the white deposit consisted of some poisonous substance which had been added by a woman with the view of poisoning her husband, the two not being on good terms. The deposit examined microscopically and micro-chemically was found to consist of an amorphous substance, giving the chemical reactions of a proteine compound, with entangled globules of oil. This rendered it probable that it consisted of the caseine of milk, with globules of butter. It was afterwards recollected that milk had been put into a tumbler kept in the place from which this had been taken; and thus the matter ended.

BIBL. See CHEMISTRY.

CASSAVA.—The coarser part of the starch (tapioca being the finer) derived from the tuberous root of the *Jatropha Manihot*, L. (*Janipha Manihot*, Knth.; *Manihot utilissima*, Pohl), a Brazilian plant of the family Euphorbiaceæ. The starch-grains are represented in Pl. 36. fig. 14.

CASSEBEE'RA, Kaulf.—A genus of Adianteæ (Polypodiæous Ferns), nearly related to *Adiantum*. Exotic.

CASSIDULI'NA, D'Orb.—A group of *Foraminifera* subordinate to *Bulimina*. The chambers are alternate in unequal pairs, and form a more or less discoidal, instead of spiral, coil. The aperture is oblique, formed by an inverted slit-like fold of the lower part of the septal face, as in *Bulimina*.

Two British recent species, *C. lævigata* (Pl. 18. fig. 45) and *crassa*, are common; and a few others, with these, are found in all seas, and in the middle and later Tertiaries.

BIBL. Williamson, *Recent Foram.* 68, figs. 140–144; Carpenter, *Introd. Foram.* 197; Parker & Jones, *Phil. Trans.* clv. 377.

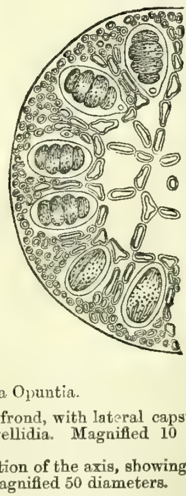
CATASCO'PIUM, Brid.—A genus of Bartramioideæ (Acrocarpous Mosses).

BIBL. Wilson, *Bryol. Brit.* p. 285; Berkeley, *Brit. Moss.* p. 168.

CATENEL'LA, Grev.—A genus of Cryptonemiaceæ (Florideous Algæ), represented by one British species, *C. Opuntia*, which is not uncommon on marine rocks near high-water mark. It presents a mass of creeping fibres, from which arise densely matted fronds 1-2 to 1″ high. Colour dull dark purple. The *favellidia* are contained in the

Fig. 102.

Fig. 103.



Catenella Opuntia.

Fig. 102. Fragment of a frond, with lateral capsular bodies containing the favellidia. Magnified 10 diameters.

Fig. 103. Transverse section of the axis, showing the immersed tetraspores. Magnified 50 diameters.

lateral capsular bodies (fig. 102); the tetraspores are imbedded in the periphery of the loosely cellular axis (fig. 103).

BIBL. Greville, *Alg. Brit.* pl. 17; Harvey, *Br. Mar. Alg.* pl. 20 B; *Phyc. Brit.* pl. 88; *Engl. Bot.* (*Rivularia Opuntia*), pl. 1868.

CATHARI'NEA, Ehrh.—A genus of Polytrichaceous Mosses, containing some of the *Polytricha* of authors, having a naked calyptra; =*Atrichum* and *Oligotrichum* of Wilson's *Bryologia*.

BIBL. Wilson, *Bryol. Brit.* pp. 202, 204.

CATTLE-PLAGUE or Rinderpest.—This terrible disease requires a brief notice on account of its microscopic relations. Careful examination of the muscles of animals which had died of it showed the presence of "Entozoa." These were found afterwards to be *Psorospermiæ*, and to exist in healthy as well as in diseased animals; so that they had no connexion with the malady.

BIBL. Beale, *Qu. Micr. Journ.* 1866, p. 141 (figs.); Cobbold, *Entozoa* (*Suppl.*), p. 40.

CAYENNE PEPPER.—This substance consists of the ground seed-vessels of various species of *Capsicum*; it is often adulterated both with substances increasing the bulk, and with mineral colouring-matters. For the detection of the former the microscope is employed, first studying the characters observed in the true unground peppers. Turmeric and rice-flour are named as falsifying substances; red earths, vermilion, and red lead are detected by chemical analysis.

BIBL. Hassall, *Food Adulterations*, p. 460.

CECIDOMY'IA, Latr.—A genus of Diptera, of the family Tipulidæ.

C. tritici is the wheat-midge, which deposits its eggs in the flowers of corn. The yellow larvæ wound the ovary, and so cause a form of blight.

C. destructor, the American wheat-midge, or Hessian fly, is still more injurious to crops.

These insects may be found among the ears of corn in the evening during the month of May or June.

BIBL. Kirby, *Linn. Trans.* iii. iv. v.; Westwood, *Intr. &c.* p. 519; Sidney, *Blights &c.* p. 109 (*Rel. Tract Soc.*).

CE'CROPS, Leach.—A genus of Crustacea, of the order Siphonostoma, and family Caligina.

C. Latreillii. Found on the sun-fish (*Orthagoriscus mola*). Female, length 1″, male 1-3″.

BIBL. Baird, *Brit. Entomost.* p. 289; V. d. Hoeven, *Handb. d. Zoologie*, i.

CEDAR.—The Cedar of Lebanon is the *Abies* or *Pinus Cedrus*. The fragrant so-called 'cedar,' of which pencils &c. are made, is the wood of *Juniperus virginiana*.

See CONIFERÆ and WOOD.

CELL, ANIMAL.—The tissues and organs of animals, like those of plants, are in great part made up of cells; but the full-grown structures of animals are strikingly distinguished in general from those of vegetables by the departure from or disguisal of the primitive cellular constitution.

Under the head of CELL, VEGETABLE, the cell is defined as a vesicle or sac consisting of a membrane composed of cellulose, containing within it a nitrogenous structure, the vital part, called the primordial utricle, or protoplasm. In animals this protoplasm may exist alone, without a membranous envelope forming the true cell or closed sac, as in *Amœba* and analogous organisms; but ordinarily the animal cell, like the vegetable, is a true shut sac, enclosing liquid or gelatinous protoplasmic contents, the membrane, however, being here almost always composed of a nitrogenous compound, and only in a few cases of cellulose or allied substances such as prevail in the solid parts of plants.

The membrane of animal cells is ordinarily transparent and colourless, mostly smooth, and so thin as to exhibit only a single boundary line; more rarely the membrane is tolerably firm, presenting a measurable thickness,—while it is sometimes very thick, and appears to consist of several layers. Occasionally the membrane has a granular appearance, arising from projections dependent on granules lying on the inside. No structure can be detected in the cell-membrane itself.

The membranous cell generally contains a liquid or semifluid protoplasm, the consistence of which varies; in this float, or are suspended, molecules, granules, globules or other very minute cells. In addition to these, we frequently find one or more of those bodies which are termed *nuclei*, often attached to some part of the cell-wall. The nuclei again contain *nucleoli.* The cell-contents likewise include, in particular structures, products of secretion,—matters separated by the cells from the circulating fluid, as in the cells of the renal epithelium, &c.,—also crystals, pigment, &c.

The *forms* presented by animal cells are not so varied, or generally so geometrical, as those occurring in the cells of vegetables.

In regard to *size*, the largest are the yelk-cells of ova, especially of Birds and Reptiles, and of some animals consisting of a single cell, as certain of those curious organisms the *Gregarinæ*.

The *nuclei* are usually spherical or lenticular, non-contractile, transparent, and colourless or yellowish. They are sometimes solid or homogeneous, at others they are vesicles, with a very delicate membrane. They sometimes contain, exclusively of the nucleolus, a transparent colourless or yellowish liquid, in which water and acetic acid produce a precipitate of granules resembling those existing in the cell-contents; hence in the ordinary manner of examining them, they seldom present their natural transparency.

The *nucleoli* are rounded, well defined, very minute, sometimes immeasurable.

Chemically, the cell-membrane ordinarily consists of a proteine compound; it is mostly dissolved, or rendered so transparent as to become invisible, by acetic acid and solution of potash. Cell-membranes composed of cellulose occur in some animals, as in the Tunicata, &c.; it is detected here, as in plants, by the action of iodine and sulphuric acid. The nucleoli consist also of a proteine-compound; they are soluble in potash, but not in acetic acid. The action of potash distinguishes them from globules of fat. The carmine-ammonia solution has a much more rapid and powerful dyeing action upon the protoplasm and the nuclei than upon the cell-walls.

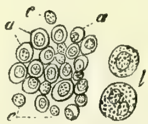
It must be remarked that the appearances interpreted to be nuclei and nucleoli, frequently are not respectively identical in kind: the nuclei are sometimes homogeneous, at others true cells; sometimes they relate to the formation of the cell, at others they are young secondary cells, vacuoles, &c.; the same applies to the nucleoli. These important points have not hitherto received sufficient attention.

Cells, or rather their protoplasms, are endowed with peculiar vital forces, by which they are capable of free movement, absorption, and the elaboration of the absorbed matter; of growth, reproduction, and of secretion. The entire organism of the higher and most of the lower animals, consists at a certain period of life, of cells, sometimes of protoplasm alone.

Formation of cells.—Cells are formed in two ways; either from a blastema, protoplasm, or formative substance existing without, or contained within, other cells. The protoplasm is a semifluid substance, consisting of proteine, fatty matter and salts.

The formation of cells *in a free blastema* is not a general process; in fact, its occurrence is now mostly denied. The only instances of its supposed occurrence in man and the higher animals were in the formation of the chyle and lymph corpuscles, the cells of certain glandular secretions (seminal cells, ova), and glandular organs (the closed follicles of the intestine, the lymphatic glands, the splenic corpuscles with the splenic pulp, and the thymus); lastly, of the cellular elements in the impregnated uterus, in the *corpus luteum*, the marrow of fœtal bones, and in the soft ossifying blastemata. In the case of the chyle and the spleen, at the commencement of cell-formation, there occur roundish, apparently homogeneous bodies of 1-11000 to 1-5600″ diameter, which, increasing in size, soon appear distinctly as vesicles (fig. 104), and on the

Fig. 104.



Magnified 350 diameters.

Contents of a Malpighian body from the spleen of an ox. *a*, small, *b*, larger cells; *c*, free nuclei.

addition of water, exhibit an internal large body resembling a nucleolus, as also several granules. The minute details of this stage of the process of formation are not accurately known. As soon as the nuclei are formed, cell-membranes are formed around them, but not always in the same manner. Sometimes the cell-wall is deposited directly around the nucleus, so that it is but little larger than the latter; at others the nucleus becomes surrounded by a larger or smaller quantity of protoplasm which becomes more solid, and around which the cell-membrane is subsequently deposited. The latter occurrence has hitherto only been satisfactorily observed in the case of the ovum, in which the germinal vesicle, *i. e.* the nucleus of the ovum-cell, which is formed first, becomes surrounded by a quantity of yelk, before the vitelline membrane is formed. On the other hand, the formation of the cell-wall directly around the nucleus has been supposed to take place in all the other localities mentioned above, and

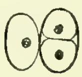
to be especially shown by the occurrence of free nuclei and larger cells, together with very small cells closely surrounding the nuclei, or separated from them by a slight interval only. It is possible that in this instance also, the cell-membrane, even at its first formation, may be separated from the nuclei by a quantity of protoplasm too minute to be detected.

The free formation of cells has been observed by Weissmann in insects during development.

The extra-cellular formation of cells is unknown in plants. And probably, when observers are agreed, it will be found that all protoplasts and cells are derived from parent-protoplasts by some form of segmentation.

The *endogenous method,* or the formation of cells within others, is very common, and may be readily observed in the tissues of embryos. In the most ordinary form of this kind of cell-formation an original or parent-cell produces within it two secondary cells, which from the first completely fill it. The first phenomenon observed in the parent-cell is the increase of the nucleus, which acquires two nucleoli, becomes elongated and resolved into two nuclei. After this the nuclei separate from each other, and a partition is formed between the cells, dividing the parent-cell into two perfectly distinct spaces, each of which encloses a nucleus and half of the contents (fig. 100).

Fig. 105.



Magnified 350 diameters.

An elongated nucleus, and one containing two secondary nuclei, from the ovum of an *Ascaris dentata.*

The exact manner in which the increase of the nucleus occurs is not certain, but it appears that the nucleoli always become resolved into two by subdivision and then separate from each other. In the nuclei, which at the same time become elongated, the first trace of division is then usually a median partition, which in favourable instances appears to arise from the presence of two secondary cells in close contact by plane surfaces and entirely filling up the parent nucleus. Very frequently nothing is seen but first an elongated nucleus with a partition and two nucleoli, and then two hemispherical nuclei in contact by their plane surfaces (fig. 105), no endogenous nucleus-formation being perceptible; in this case, division of the nucleus has taken place, the parent-nucleus containing two nucleoli becoming finally resolved into two by a deeper and deeper constriction. This mode of cell-formation is often continuously repeated, frequently so long as the growth of the organism continues. The parent-cells then either continue their existence as such, or they disappear sooner or later as histologically distinct formations, and become consolidated with the substance connecting the cells.

The occurrence of this endogenous cell-formation, which agrees essentially with the formation of cells in a free protoplasm, is well established in the case of the young cartilages of all animals, and also probably occurs in embryonic organs in general, in which, from the period at which they consist of true cells, the entire growth depends upon the multiplication of the existing cells without free cell-formation. It also occurs in pathological products, as in cancer.

In addition to this, the most common kind of endogenous cell-formation, there are others, viz.

a. In the ova of most animals at the earliest period of development, a peculiar process occurs called the segmentation of the yelk, which must be regarded as preliminary to the formation of the first embryonic cells, and which, as the ovum bears the import of a simple cell, falls under the type of endogenous cell-formation. The essential features of the segmentation are as follows. After the original nucleus of the ovum-cell —the germinal vesicle—has disappeared in consequence of impregnation, the granules of the yelk no longer remain aggregated into a compact mass as before, but become distributed throughout the entire cell. The first sign of commencing development is then constituted by the formation of a new nucleus—the first embryonic nucleus, around a new nucleolus, which acts as a centre of attraction to the yelk, and causes it to reunite into a globular mass—the first globule of segmentation. In further development two new nucleoli are formed from the first nucleus by endogenous growth, which, as soon as they are set free by the development of the parent nucleus, become separate from each other, act as new centres to the yelk-granules, and thus the first globule of segmentation become resolved into two.

The increase of the nuclei and of the globules of segmentation continues in the same way, the first always preceding, until a very large number of small globules are present, which entirely fill up the yelk-cell; sometimes, but exceptionally, the globules are not resolved until the nuclei have become increased to three or four, so that three or four globules are formed from each, instead of two. This process is termed total segmentation, because here the entire yelk is applied to the newly-formed nuclei: partial segmentation agrees with this in all essentials, and only differs from it in the circumstance that in it, not the whole of the yelk, but a larger or smaller part of it, varying in different animals, envelopes the nuclei in process of formation (figs. 106–108).

Fig. 106.

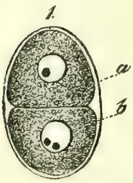


Fig. 107.

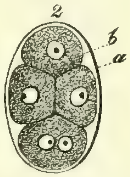
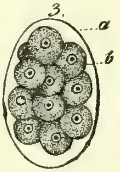


Fig. 108.



Magnified 350 diameters.

Three ova of an *Ascaris nigrovenosa*; 1, in the first, 2, in the second, and 3, in the third stage of segmentation, with two, four and sixteen segmentation-globules. *a*, outer coat of the ovum; *b*, segmentation-globules. In 1, the nucleus of the lowest globule contains two nucleoli; in 2, the lowest globule two nuclei.

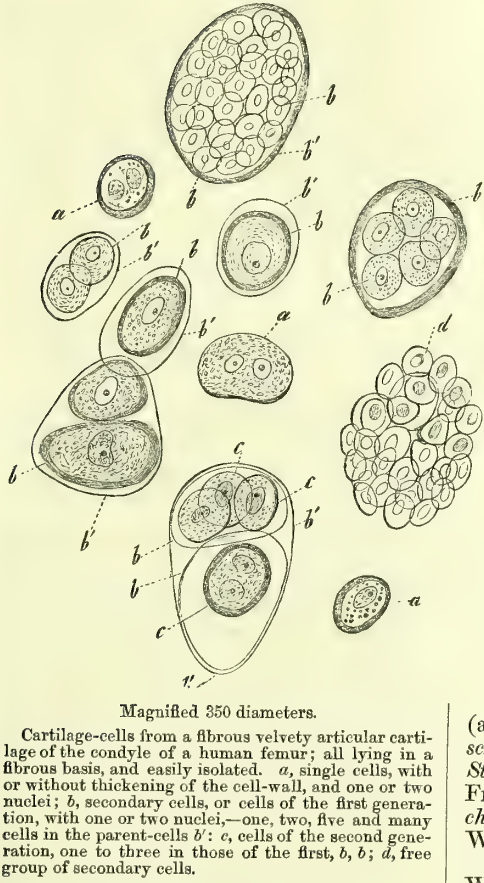
When the process of segmentation has reached a certain stage, the segmentation-globules become surrounded with membranes and form true cells, whence it appears justifiable to arrange this process with endogenous cell-formation. In fact it is nothing more than a preliminary to cell-formation in the ovum-cell, and only differs from the ordinary phenomena of this kind in the circumstance that, first, the nucleus of the parent-cell or the germinal vesicle in most cases has nothing to do with it; secondly, the parent-cell itself persists; and, thirdly, the portions of the contents formed in it by the successive increase of nuclei do not assume the form of cells until subsequent generations. This view is moreover justified, since the cells formed from the last segmentation-globules continue for a long period to multiply by endogenous production (or division), and the entire segmentation-process may be regarded as a kind of endogenous cell-formation, in which, on account of the rapidity with which the nuclei increase, in the first generation of globules it does not come to the formation of membranes (see Ovum).

b. In some respects allied to segmentation are those forms of endogenous cell-formation in which a greater or less number of secondary cells are formed within persistent parent-cells, as seen here and there in cartilage, the suprarenal capsules, the pituitary body, &c. In this case, either two secondary cells are formed in the usual way in a cell, almost or entirely filling it, and from these other generations, either free or all or individual ones enclosed in parent-cells of the second and subsequent generations; or only one secondary cell is formed in a cell, whence cell-formation then proceeds in either manner (fig. 109); or the secondary cell is formed in a bud-like protrusion of the parent-cell (see Echinococcus).

The formation of a larger number of nuclei within cells, which frequently precedes cell-formation, but may also exist alone, may be well arranged under endogenous cell-growth. Even in ordinary endogenous cell-formation (and also in segmentation) we not unfrequently find three and four nuclei in one parent-cell, so that then, instead of two, a larger number of secondary cells are formed at once, as *e. g.* in the liver-cells of embryos. In certain animals (*Cucullanus*, *Ascaris dentata*, *Distoma* and the Cestoidea), instead of segmentation-globules, in the first stage of development nuclei only are formed in the ovum-cell, which do not become surrounded by cell-membranes until they have accumulated into a large heap by successive endogenous growth. The same appears to take place in the cells of the germ of the Crustacea, in which from ten to twenty nuclei frequently exist. The numerous nuclei, however, in the seminal cells of most animals appear usually to have no connexion with cell-formation, because the seminal filaments are developed within them; and the same applies to those cells of the lower animals, the numerous nuclei of which are converted into urticating organs. Whether in these cases the nuclei multiply by division or endogenous growth is unknown.

Cell-formation by division has been observed in the coloured blood-corpuscles of the embryos of Birds and Mammalia, and the earliest colourless blood-corpuscles of the larvæ of frogs (tadpoles); it also probably occurs in the colourless blood-corpuscles of embryos and the chyle-cor-

Fig. 109.



Magnified 350 diameters.

Cartilage-cells from a fibrous velvety articular cartilage of the condyle of a human femur; all lying in a fibrous basis, and easily isolated. *a*, single cells, with or without thickening of the cell-wall, and one or two nuclei; *b*, secondary cells, or cells of the first generation, with one or two nuclei,—one, two, five and many cells in the parent-cells *b′*: *c*, cells of the second generation, one to three in those of the first, *b*, *b*; *d*, free group of secondary cells.

puscles of adult Mammals. In all these cases, the cells first become elongated, and the single nuclei appear to become divided into two; the cells are then constricted in the middle and finally resolved into two, each with a nucleus (Pl. 40. fig. 36).

A peculiar kind of cell-growth, most nearly allied to division, occurs in the cells of the ivory of the teeth; in which, while continually elongating, the nuclei enlarge from time to time and become constricted, so that whilst that portion next the ivory ossifies, the remainder serves to a certain extent as a reserve for the subsequent formation of newly ossifying portions (fig. 110).

The term cell is frequently used, in a totally different sense, to denote a partially closed space, or the cup-like body enclosing

Fig. 110.

Magnified 350 diameters.

Ivory-cells from the tooth of a dog.

the space; as in the case of the cells of a Polype, or Polyzoon, the cells of a sponge, &c.

Bibl. *Treatises on Physiology*; Schwann, *Ueber die Einstimmung, &c.* (*Sydenham Soc.*); id. *Wagner's Physiol.* by Willis; Valentin, *Phys.*; Kölliker, *Gewebelehre d. Menschen* (and the literature therein); Siebold, *Zeitschr. f. Wissens. Zool.* i. p. 270; Rollett, *Stricker's Handbuch* (*New Syd. Soc.*) i.; Frey, *Histologie*; Cohnheim, *Virchow's Archiv*, xl.; Recklinghausen, *ibid.* xxviii.; Weissmann, *Zeitsch. f. Rat. Med.* 3rd ser. xv.

CELL, Animal, *artificial formation of.*—When oil is immersed in a liquid containing albumen, it becomes surrounded by a layer of coagulated albumen, forming a cell; and this cell will exhibit the phenomena of endosmose and exosmose in the same manner as any natural cell. The same phenomenon has been observed with metallic mercury and albumen, chloroform and albumen, chloroform and chondrine, &c. It has not yet been satisfactorily explained. The natural formation of cells has been supposed to be produced by this method; but it appears inapplicable to the purpose, as the nuclei or masses of blastema, around which cells are formed, do not consist of fat.

See Concretions.

Bibl. (Of the above;) Ascherson, *Müller's Archiv*, 1840, p. 44, &c.; Wittich, *De hymenogonia albuminis*, Regiomont. 1850; Harting,

Neder. Lanc. Sept. 1851; Melsens, *Bull. de l'Acad. de Belg.* 1850; Panum, *Archiv f. Path. Anat.* iv. 2; Bennett, *Ed. Month. Journ.* viii. p. 166; Kölliker, *Gewebelehre d. Mensch.* p. 10; Schmidt, *Taylor's Scientific Memoirs,* v. p. 10.

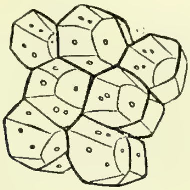
CELL, Vegetable.—The definition of the term *cell* in vegetable anatomy, ordinarily adopted, is, *a closed sac composed of an (originally) imperforate membrane formed of the chemical substance called cellulose, this membrane enclosing fluid contents so long as the cell retains its vitality.* All the solid permanent structures of plants are formed of cells answering to this character, the differences of the full-grown tissues depending upon peculiar modifications and alterations of the original cells. In animal structures, the term cell is commonly applied, not only to structures really analogous to the cells of plants, but also to structures analogous to the *contents* of the true cellulose cells, which, however, are indeed in all cases the important living parts of the structure. All young vegetable cells contain a quantity of semi-fluid nitrogenous formative substance called *protoplasm,* which protoplasm may be chiefly adherent as a thickish and more or less continuous layer to the inside of the cellulose wall, forming a kind of lining to it, and therefore enclosing all the rest of the contents, in which case it is called the *primordial utricle* (*primordial-schlauch* of Mohl); or this dense protoplasm may fill up the whole cavity of the cell as a gelatinous mass;—or, finally, the gelatinous mass of protoplasm may emerge from the cellulose sac, with a definite form and organization, furnished with cilia enabling it to move freely in water; and here the *primordial utricle* presents itself as independent, and indeed as the primary element of all cellular tissue; it is found in this condition in the Confervoid Algæ, in the zoospores. These free bodies, devoid at first of a cellulose wall, are evidently analogous to the corpuscles of 'sarcode' constituting certain animals, such as *Amœba,* while the cartilage-cells &c. of animals are analogous to the cellulose sacs of plants; so that the confusion which exists in the animal tissues is likely to extend to vegetable tissues if we adopt the name which has been proposed by the Germans for these free protoplasmic organisms, namely, that of *primordial cells.* Since the structure to which the name *cell* is at present applied in vegetable anatomy is in pretty close accordance with the common acceptation of that word in ordinary language, indicating a hollow case, it seems unadvisable to change the received nomenclature, while it is evident that the use of the prefix *primordial* to the word *cell* is not distinctive enough, and will beget confusion; hence it seems desirable to apply a special name to the newly detected and definite form of organization, the free protoplasmic corpuscle. The term *primordial utricle* answers all requirements, since the isolated body is chemically and physiologically identical with the ordinary primordial utricle lining a nascent cell, having in like manner the function of forming a true cell by secreting a layer of cellulose all over its external surface and thus enclosing itself in a sac.

In this work, then, the word cell, as applied to vegetable structures, is always used in its ordinary sense, and the character of the "primordial cell" of Cohn and other German authors is given under the head of Primordial Utricle.

Form.—Cells may present almost every possible modification of form, and this depends on two sets of conditions, the original development and shape, and the mode of growth and expansion. It is frequently stated that the primary form of all vegetable cells is that of a sphere, or at all events that this is the *type* from which all the others must be considered deviations. This is true only so far as it is intended to signify that most cells which originate free in the midst of fluid, suffering no external compression, have a globular form, and that in *numerous* cases where cellular tissues are very lax and free to expand in all directions, the component cells acquire a globular form during the enlargement to their full size. But in a very large majority of cases the cells do not originate in a free condition, they are produced by subdivision of older cells, and consequently, when first developed, they have the shape of the half, the quarter, or whatever segment it may be of the parent-cell; moreover, in a majority of these cases the mode of expansion also depends upon a special law of the particular tissue, or even of such tissue in the particular group to which the plant belongs, and not upon any general law of globular expansion. The above law does prevail widely in some families, as in the Fungi, and we very frequently see it prevailing in pith up to a certain period; but it will not hold as a general rule; for the lax tissues of leaves, of succulent stems, &c.

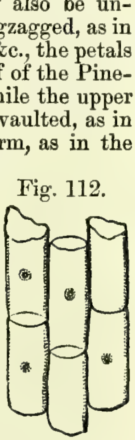
offer most striking deviations, as do also the varied and often elegant forms of lower Algæ. It is further stated in many books, that the effect of pressure on cells having a tendency to become globular, is the production of a dodecahedral form; but this again is far too sweeping a generalization, and the real fact is that globular cells of equal size, expanding in a confined space, often become twelve-sided by mutual pressure, but far more often the cells of a tissue are of diverse size, and hence a polyhedral form is much more common (fig. 111). Cells may be

Fig. 111.



globular, as in the Yeast-plant, and many lower Algæ, in the lax tissue of young pith of many Dicotyledons (Pl. 38. fig. 14), &c.; oval, as is much more common in parenchymatous tissues; squarish, as in cork (Pl. 38. figs. 16, 17); or tabular, as in the epidermis of numerous plants, under which circumstances the side walls may be square, rhombic, hexagonal or irregular, as in many petals; and the outlines may also be undulated or even beautifully zigzagged, as in the leaf of *Helleborus fœtidus* &c., the petals of many flowers, or in the leaf of the Pine-apple (Pl. 38. fig. 15), &c.; while the upper exposed face may be flat or vaulted, as in most petals, or even papilliform, as in the petals of the Sweet William and of most flowers with glistening surface. Cells may also be cylindrical, and then either with flat ends (fig. 112), as in the parenchyma of many Monocotyledons and in the filaments of Confervæ, or rounded ends or attenuated ends, as in wood and liber tissue generally; or they may be prismatic, and then square or six-sided, as in stems of most

Fig. 112.



herbaceous plants; spindle-shaped, as in a large number of woods, such as that of Conifers, Box, &c.; and, in fact, of almost every conceivable form. In lax tissues, the walls of the cells often grow very unequally at different points, whence result angular projections (by which the cells ordinarily cohere together) (fig. 113); or these grow out into arms or rays, producing stellate cells, as in the pith of the Rush (Pl. 38. fig. 18), and the parenchyma of many aquatic plants, in the leaf-stalk of the Banana, &c. Cells which are free, as in the lower Cellular plants, sometimes grow out into long tubular structures such as *Vaucheria*, with a continuous cavity, and indeed sometimes ramify into a complication of branches, as in *Bryopsis* and *Codium*, while in *Botrydium* (fig. 75) the globular cell sends down a number of root-like filaments which are mere protrusions of its own wall. The cells of *Chara* attain very large size. In the Flowering plants we have an example of extraordinary growth of a single cell in the pollen-tubes, which, in some cases, become as much as three inches long.

Fig. 113.

Size.—The dimensions of cells vary to infinity, and, indeed, often extremely in one and the same tissue, but not as a rule. And the diameter of cells is very frequently incomparably less than the length, as in all filamentous and fibrous cells. Taking a very general view, we may say that parenchyma-cells vary from 1-250 to 1-1000″ in diameter; but the spores of many Fungi measure no more than 1-6000 to 1-8000″, while the cells of the juicy parenchyma of many fruits and piths attain as much as 1-100″.

The smallest cells appear to occur in *Palmella hyalina*, where they measure the 1-83,000″. In elongated cells, such as those of liber and most woods, the diameter is ordinarily less than in parenchyma, while the length is far greater: thus in wood the length varies from about 1-40 to 1-12″, while the diameters are respectively 1-300 and 1-100″; in liber the length may extend to 1-8 or 1-4″, with a diameter of 1-800 and 1-400″. (See Fibres.) Hairs composed of a single cell often attain a great length, as in Cotton, where a single filamentous cell may measure 1 to 2″. (See Tissues, *Vegetable.*)

Cells may be examined either *in situ*, as parts of tissues, or free, separated naturally or artificially. For the first it is simply requisite to make fine slices with a razor, in various directions through the structure; if soft or thin it should be placed between the

two halves of a split vial-cork and sliced with the cork, the cork being afterwards removed from the slide with a needle. Slices of many kinds of cellular tissue are made more clear by the addition of a little diluted sulphuric acid, which, however, often swells up some of the layers.

For examining isolated or nearly separate cells, we may take the lower Algæ or Fungi, or germinating spores of the higher plants, or we may separate the cells of the tissues of higher plants. The parenchymatous tissues may usually be separated into their elementary cells by maceration in water: the decomposing ends of flowerstalks which have been in water several days will generally afford tissue in such a state that it may be broken up with a needle; in the pulp of ripe fruits, such as currants, strawberries, &c., mere pressure separates the cells. Boiling will do with some of the denser kinds; while for the woody tissues it is requisite to heat fragments with a particle of chlorate of potash and a drop of nitric acid (or let them macerate for 12 to 24 hours), and wash them well with water: liber-cells, woody cells, &c. may be isolated by this means; or still better by treating them with chromo-sulphuric acid (Intr. p. xl).

Formation of Cells.—This subject has undergone a great amount of investigation during the last few years, and the views which have been propounded at various times have conflicted strongly in many points. It would be exceeding our limits, however, to enter upon a critical examination of the theories of cell-development, and we shall therefore confine ourselves to a brief account of those phenomena and laws of the reproduction of cells upon which the diversity of opinion only affects subordinate particulars.

All vegetable cells (using this term in the sense of the *cellulose sac with contents*, as defined above) in which the capacity for reproduction exists, contain an internal structure, varying in its condition and appearance at different epochs and in different plants or parts of plants, called, in accordance with Mohl's proposal, the *primordial utricle*. This structure consists of a layer of the *protoplasm*, a semifluid nitrogenous substance, lining the cellulose wall of the cell. All the other cell-contents are enclosed or imbedded in this primordial utricle, and with it they collectively constitute what is called by some authors the *endochrome* of the cell. The characters of the Primordial Utricle and of the Protoplasm are given in the requisite detail under their respective heads.

In a very large number of cases, we find in the primordial utricle at this time, a peculiar body called the *nucleus*, to which some writers attribute great importance in the development of cells. Its nature is not well defined; but in the best observed cases it consists of a small globular or lenticular mass, apparently composed of protoplasm in a condensed and granular (solid) condition. It mostly exhibits one or more bright granules or points in its substance, which are called *nucleoli*. Many authors consider this body of the first importance in cell-development; but as we are by no means satisfied as to the character of its agency, its peculiarities and its relations to the cell are spoken of separately under the head of Nucleus (Pl. 38. figs. 8, 9 *n*).

All development of new cells depends upon the division of the primordial utricle of existing cells into two or more portions, which, becoming independent centres of life, produce new cellulose membranes, and become new cells. The phenomena in which this law is manifested are far more varied than would be imagined from this simple statement. The numerous subordinate modifications, however, may be arranged under three principal heads:—1. *Cell-division*, sometimes called *merismatic* cell-formation; 2. *Cell-division with liberation of the new cells*; 3. *Free cell-formation.*

1. *Cell-division* is the process which occurs in all reproduction of cells connected with vegetative growth or increase of the mass of existing structures. This is the manner in which the cells are multiplied in the growth of the thallus of the inferior plants, and in the growth of the stems, leaves, roots, and other organs of the higher plants. It occurs also in the formation of the *basidiospores* or *stylospores* of Fungi, the *spermatia* of these and Lichens, of *gonidia* in the Lichens, and *conidia* in the Fungi. The essential fact observed in all the cases is, the division of the primordial utricle of the parent-cell into two or more distinct primordial utricles, each of which secretes a layer of cellulose over its whole surface; and thus, when the two are in apposition, a partition is formed dividing the parent-cell into two or more parts. The form of the *daughter-cells* depends of course on that of the parent-cell at the time of division. In the case of cellulose tissues, such as those in the *punctum vegetationis* of the buds of the higher plants,

in *cambium*, &c., the division is ordinarily into two halves, which respectively grow until equal in size to the parent; and either both or only one of these divides again in the same way, and so on, until the whole structure is completed. It is evident that the external forms of all cellular structures must depend greatly upon the laws of division of the cells of plants. For example, supposing we start from a single square cell, when this divides into two halves, and these grow to equal the parent-cell, we have an oblong figure; if the half-cells divide again in the same direction, we shall in time get a long filament; and if *both* new cells divide again each time, the filament will grow much longer in a given time than if only the *end-cell* continually divided, leaving one new cell behind it at each division. If the pair of cells produced by the first halving divide at right angles to the first division, a square group of four cells results; and if this law continues to act, a flat plate of cellular tissue will result. Further, if the cells also divide by horizontal partitions (in the third direction of space), the mass of cells will gradually acquire thickness or height as well as length and breadth. Lastly, if the cells of particular regions cease to divide sooner than others, irregular or complex but definite structures will be produced—as those parts where the cell-division goes on will emerge from the general mass, in the Cellular plants as lobes, and in the higher plants as conical bodies which are gradually developed under similar laws into the organs. The diversities of internal organization depend also to some extent on the same laws, but less on these than on the laws regulating the forms which the cells acquire when full-grown.

Cell-division may be observed most easily in the lower Cellular plants, or in the simpler structures (such as hairs) of the higher plants (Pl. 38. figs. 8, 9). The Confervæ afford exceedingly favourable opportunities, as do also the filamentous or thalloid structures of germinating Mosses, Ferns, microscopic Fungi, &c. The behaviour of the parent-cell before division exhibits some diversities. If a simple filament is increasing by cell-division, the cylindrical parent-cells merely elongate a little before dividing transversely. If the filament is to branch, the wall of the parent-cell bulges out gradually at the point where the branch is to appear; the bulging soon becomes a pouch, and this pouch is soon shut off by the formation of a partition at its base. Bead-like rows of cells likewise divide by budding in this way, as may be observed, for instance, in the Yeast-plant: the new cell first appears as a little 'bubble' on the side of the parent, with its cavity continuous; and after it has acquired a certain size, its primordial utricle detaches itself from that of the parent, and a partition is formed at the point whence the second cell emerged (Pl. 20. fig. 23).

Another point which must be noticed here, is the question whether the parent primordial utricle divides *instantaneously*, at a given epoch, into the new utricles, or whether it parts gradually, by a sort of constriction advancing from the surface towards the centre, roughly comparable to what occurs when a ligature is slowly drawn tight round an elastic tube, or when a bar of soap is cut in two by passing a string round it and gradually drawing the loop tight. It seems probable that the segmentation of the primordial utricle is always gradual, and it is certain that it is so in many cases. Its gradual constriction has been observed in those Confervæ where the primordial utricle is a hollow sac, forming a lining over the whole internal surface of the parent-cell; it may be traced in the larger Confervæ, in *Spirogyra*, &c., by keeping the plants growing in water under the microscope. It appears that the division is generally completed during the earlier hours of the morning.

2. *Cell-division with liberation of the new cells.*—The first step in this process is analogous to what takes place at the outset in the preceding set of cases; but we find much more important modifications here. This is the mode of development of spores of the Ascomycetous Fungi, of the spores and tetraspores of the Algæ, the spores of Lichens, the spores of all the higher Cryptogamia, the active gonidia or zoospores of the Algæ, the parent-cells of the spermatozoids or active spiral filaments of the higher Cryptogamia, and of the pollen-grains of the Flowering plants.

The general character is: Division of the whole primordial utricle into segments, which either acquire a cellulose coat within the parent-cell before they are set free by its solution or bursting, or escape from the parent-cell without a cellulose coat, and secrete this afterwards.

The following modifications occur:—

a. Division of a nearly solid primordial utricle into four, either directly or by two halvings. This occurs in the development of pollen and of the spores of Mosses, Ferns,

&c. The parent-cells of the pollen or spores become free in the interior of the anther or sporange, by the solution of the walls and septa of their parent-cells. The primordial utricles of the free cells divide into four segments, entirely filling the cell. After this, either partitions are formed between these (pollen-cells), to be subsequently dissolved, or they at once clothe themselves with a cellular coat (*Marchantia*). In either case, they ultimately lie free in the parent-cell, which is itself finally dissolved (Pl. 38. figs. 10–13).

b. Division of a homogeneous primordial utricle into a large number of segments, each of which acquires a cellulose coat, the whole of the new cells lying closely packed but free in the parent-cell. This occurs in the antheridia of the higher Cryptogamous plants, in the formation of the parent-cells of the spermatozoids, also in the formation of the parent-cells of the spores and the elater-cells of the Hepaticæ. The formation of the spores in the asci or thecæ of the Ascomycetous Fungi and the Lichens belongs either to this or the preceding case (Pl. 29. fig. 12).

c. Division of the homogeneous primordial utricle into segments which do not acquire a cellulose coat until after they are discharged from the parent-cell. This occurs in the development of the zoospores of most of the Confervoideæ (*Cladophora*, *Bryopsis*, *Achlya*, *Ulothrix*, &c.), where the primordial utricles become free in the cavity of the parent-cell when they divide, and break their way out into the water, where they form a cellulose coat after they have swum about freely for some time by means of their cilia.

d. Division of a sac-like primordial utricle into a number of portions, which appear at first as papillæ on the walls of the cell, and finally become isolated in the cavity. This occurs in the development of the gonidia of *Hydrodictyon*, *Botrydium*, &c. These last two cases are connected with *a* and *b* by the circumstance that the zoospores or active gonidia are replaced, under certain circumstances, by cells; that is, the bodies produced in this way acquire a cellulose coat before they leave the parent-cell.

Numerous intermediate conditions occur which connect all these together; and the last case, *d*, does not differ essentially from what takes place in the formation of the endosperm-cells, placed under 3.

3. *Free Cell-formation.*—Here the new cell is formed by a portion of the parent primordial utricle separating itself from the rest of the protoplasm, assuming a globular or oval form, and secreting a cellulose membrane upon its surface, so as to form a new cell lying free in the cavity of the parent primordial utricle. The most remarkable instance of this case is the formation of the germinal vesicles in the embryo-sac of the Flowering Plants (Pl. 38. figs. 1–4). Other cells sometimes occur, formed in the same way, at the opposite end of the embryo-sac. The embryo-sac also frequently becomes filled, after fertilization, by a large increase of free cells developed out of the layer of protoplasm or primordial utricle lining the walls; these (*endosperm-cells*) accumulate in the sac, and sometimes become consolidated into a tissue (albumen) in which the embryo lies imbedded; in exalbuminous seeds they are re-absorbed during the growth of the embryo. The embryo itself is developed from the germinal vesicle by cell-division such as is described under § 1 (Pl. 38. figs. 5, 6).

Karsten considers that the formation of every cell within a living organ is original; and that the cell is not divided into two new individuals by transverse septa or proliferation.

The hypotheses of the independent origin of cells from organic substances by *generatio æquivoca* seem to require no notice; but allusion may be made to certain curious phenomena which have been called 'abnormal cell-formations,' occurring in some of the Confervoids. The protoplasm of the Siphoneæ is very apt to collect into globular masses in injured filaments; and these globular masses apparently acquire a cellulose coat in some cases: they have been observed in *Vaucheria* and *Bryopsis*; a somewhat similar phenomenon often occurs in the contents of the cells of *Spirogyra*. It appears to be a kind of gonidial reproduction, in which a portion of the living contents are enabled to save themselves from the general decomposition. (See Pseudogonidia.) Some forms which we incline to refer here, have been described as distinct genera and species of parasitic Algæ; on this subject see Parasites, Chytridium, Pythium.

Membrane.—In all young organs of succulent structures, and all the delicate tissues of the higher plants, and in the majority of the Cellular plants in almost the entire organization, the cellular membranes consist of a thin structureless pellicle, possessing a

considerable degree of toughness and a certain amount of elasticity. (C. J. Agardh has indeed asserted that cell-membrane is composed of spiral fibrous structure, but this doubtless is an error as regards the primary membrane.) It is readily permeable by water, while no orifices of any kind can be detected in it; but young, and indeed soft cell-membranes generally, imbibe more or less water, and swell to some extent, often becoming more or less gelatinous. It is stated by Schleiden that the membranes of nascent cells are soluble in water, but general experience does not confirm this statement; the only approach to a corroboration of it that we have met with, is in the lower Algæ: the zoospores are often extruded in the interior of an extremely delicate sac formed of cellulose, which almost immediately vanishes and sets the zoospores free. The external membranes of many of the filamentous and unicellular Algæ become gelatinous, and gradually dissolve away as the inner membranes are successively deposited, forming a gelatinous coat (*ex. gr. Protococcus, Nostoc*, Desmidiaceæ, Diatomaceæ, *Zygnema*, Oscillatorieæ, &c.); the same also takes place in the development of spores and pollen-grains, which are set free by the parent-cell membranes becoming dissolved. This, however, is scarcely direct solution in water, and comes rather under the head of decomposition.

Young and delicate cell-membranes are perfectly transparent and colourless, as is seen in the Yeast-plant, in the mycelium of Mildews, in the cellular tissue of tuberous structures like the Potato, in piths (after the mucilaginous cell-contents have been removed). As they grow older, they often become coloured, sometimes very deeply, which is supposed, however, to depend on the infiltration of foreign matters. In the state of simple cell-membranes, where no infiltration of foreign matter has occurred, the application of sulphuric acid of moderate strength, with solution of iodine in solution of iodide of potassium, brings out a bright blue colour; and this is regarded as a test for cellulose, the universal basis of vegetable cell-membrane.

When the cell has attained a certain age, new deposits of membranous substance take place inside; and the walls thus acquire more or less thickness, together with a very varied appearance, according to the character of the deposits. The new layers are known as SECONDARY LAYERS; and the term *Cell-wall* is perhaps the most convenient collective term which can be applied to the various structures produced by the deposition of new layers of cellulose upon the inside of the primary cell-membrane. Although these new deposits are thin layers of cellulose like the primary membrane, they are rarely so totally devoid of detail structure, and in the majority of cases exhibit orifices and irregularities of the most striking character. Moreover, in one class of cases, they are not deposited as a continuous coat, but as a fibrous structure applied upon the primary membrane, as in spiral-fibrous cells; and in wood-cells they are formed one above another to such a thickness that the cell-wall loses its original membranous character, and becomes a solid case, with the internal cavity reduced to a comparatively small chamber in the centre.

The simplest condition of a thickened cell-wall is that met with in the unicellular and filamentous Algæ, where the primary membrane becomes coated in the interior by successive continuous layers of cellulose exactly resembling itself, and which often indeed can only be known to exist by comparing the thickness of old and young cells, since no lamellation can be detected; generally speaking, however, the action of moderately diluted sulphuric acid swells up such membranes, and renders the lamellæ more or less distinct (Pl. 38. fig. 24). The thickening layers of the unicellular and filamentous Algæ are scarcely to be compared with those of the cells of higher plants, since they are rather to be regarded as the primary membranes of new cells produced in the interior of the older cells, in many cases set free by the solution of the latter. These cell-walls sometimes exhibit peculiar fibrous appearances. See SPIRAL STRUCTURES.

These layers may be coloured blue by sulphuric acid and iodine; when very young even by iodine alone; but when old or where they undergo spontaneous solution into a kind of jelly, as in filamentous Algæ, this cellulose reaction seems to fail—at all events it is so uncertain in its behaviour, that, although it gives a positive result in successful cases, a negative result is altogether inconclusive.

In the cells of the generality of plants of higher organization, the secondary cell-membranes exhibit a striking difference from the primary, inasmuch as we find them constantly perforated by holes, slits, or orifices of some shape, so as to leave the primary

membrane bare, whence results a spotted or streaked appearance of the cell-wall, as may be seen even in cells with the walls still very thin, such as fully-formed pith-cells of the Elder.

The earlier anatomists regarded these spots or dots as orifices through the cell-wall; but they are in reality only *pits* opening into the cavity of the cell, and closed externally by the original membrane of the cell. When the cell-wall becomes much thickened, as in cells of horny albumen or wood-cells, the layers successively deposited over the inside, mostly correspond pretty exactly with the earliest layers, and leave the spots always free, so that these become gradually converted into tubular canals running through the thick cell-walls (Pl. 38. figs. 21–23 and 27). In the majority of cases, but not in all, the spots or pits in the cell-wall are opposite to similar spots in the walls of the adjacent cells, so that the cavities of the two contiguous cells are only separated from each other by the primary membrane of each, as at first, allowing free permeation of fluid from one to the other. In old cells these primary membranes become destroyed, and thus the cavities communicate freely through these canals running out through their hard thickened walls. The various complications of these pits are spoken of under the head of PITTED CELLS.

The secondary layers are further distinguished from the primary membrane by the prevalence of a tendency to assume the character of spiral bands or fibres winding upon the original cell-wall. This may be detected even in many cells which remain quite membranous, as in some *Confervæ* and many hairs, also in pitted lignified cells, where the thickening layer forms a general coat upon the inside of the cell; the liber-cells of many plants exhibit a delicate spiral striation of their walls, while some liber-cells display it with especial distinctness. Some of these cells give way in a spiral direction when torn by pulling lengthwise. In parenchymatous cells this spiral structure is often very fully developed in all its varieties; but it is especially characteristic of the vessels and ducts, while in certain woods, as in TAXUS, we have a combination of the porous with the spiral secondary deposits, the earlier thickening layers leaving spots uncovered while the latter ones are deposited along a spiral line coiling up the cell-wall from bottom to top, and thus the cell appears to have a spiral fibre lying upon its walls. These structures are spoken of at length under the heads of SPIRAL DEPOSITS and PITTED CELLS.

Cellulose is distinguished, when in the form of membrane or fibrous structure, by the blue colour it usually assumes when treated with iodine (starch differs in its granular form and its solubility in acids and potash, and its swelling up in hot water). The nitrogenous protoplasm is always coloured yellow-brown by iodine. The blue colour appears in many membranous parenchymatous tissues when the cells are soaked in tincture of iodine, dried, and then wetted with water. In other cases it is necessary to apply dilute sulphuric acid and solution of iodine simultaneously. It is sometimes difficult to bring out the blue reaction in old cells; various methods are had recourse to for this purpose. In corky or other epidermal tissues, the blue colour of cellulose may be brought out by soaking the cells for twenty-four hours or more in strong solution of potash, washing it well, soaking in tincture of iodine, drying, and then wetting with water. Old wood-cells undergo the same change by boiling in nitric acid, instead of treating with caustic potash, and then adding the iodine, &c. as above. All the solid structures of cell-membranes yield to one or other of these means, and exhibit the blue colour with iodine, which, if not indicative of a composition of cellulose, points to a substance intermediate between this and starch, produced out of the cellulose by the chemical action. The most characteristic property of cellulose, however, is its solubility in ammoniuret of copper. (See CELLULOSE and CHEMICAL REAGENTS.) The cells of Fungi and many Lichens and Algæ do not exhibit the ordinary reactions of cellulose, becoming brown instead of blue with iodine and sulphuric acid, and they are moreover not dissolved by ammoniuret of copper; while certain cell-walls of Lichens are coloured blue by iodine alone, from the presence of granulose. Cell-membranes and their modifications are examined, of course, in similar preparations to those mentioned as displaying the forms &c. of cells.

BIBL.—General. Henfrey, *Elementary Course of Botany* (Masters); Mohl, *Vegetable Cell*, transl. by Henfrey, 1853; Schacht, *Die Pflanzenzelle*, Berlin, 1852; Unger, *Anat. u. Phys. Pflanzen*, Vienna, 1855; Meyen, *Pflanzenphys. Phytotomie*; Morren, *Bull. de l'Acad. de Bruxelles*, v. No. 3.—Development. Two works, indispensable for the study of the

state of this question, contain citations of most of the important authorities, viz. Mohl, *Vegetable Cell*, and Braun, *Rejuv.* (*Ray Society*, 1853); Pringsheim, *Bau d. Pflanzenzelle*, Berlin, 1854.—Cell-Membrane. Mohl, *On Cellulose, Bot. Zeitung.* v. (*Scientific Memoirs*, 2nd ser. vol. i. 90); *Bot. Zeit.* xi. 753; Harting, *Mulder's Physiol. Chem.* transl. by Fromberg, Edinb. 1849; *Botan. Zeitung*, v. 337; Kützing, *Phil. Botanik*, 1852; J. G. Agardh, *De Cell. vegetabili*, &c., Lund. 1852; Caspary, *Ueb. Streifung der Zellenwand*, *Bot. Zeit.* xi. 801; Crüger, *Die Primitive Faser*, *Bot. Zeit.* xii. 57, xiii. p. 601; Dippel, *Vegetab. Zellenbild.* 1858; Hofmeister, *Handb. d. phys. Bot.* i.; Karsten, *Ann. Nat. Hist.* 1863, xii. p. 1; 1864, xiii. pp. 265, 409, 479; xiv. pp. 24, 124, 185. See also PRIMORDIAL UTRICLE.

CELL-CONTENTS.—This term corresponds, in regard to vegetables, to the word *endochrome* as used by Thwaites, Ralfs, and some of the French botanists. It refers here most essentially to the primordial utricle, as this is the part effective in development, while the substances imbedded in or lying in the cavity of this are variable according to age, stage of development, &c. See PRIMORDIAL UTRICLE.

CELLE'PORA, Fabr.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Celleporidæ.

Distinguished by the massive, globose, and incrusting, or erect and branched, calcareous polypidom, and the irregularly heaped vasiform cells, vertical to the common plane, with a beak on one or both sides, furnished with an avicularium. Five British species.

1. *C. pumicosa.* Rough, porous, massive; cells suborbicular, the mouth round. Common.

2. *C. vitrina.* Incrusting; cells ovoid, very small, pearly, and irregularly arranged.

BIBL. Johnston, *Brit. Zooph.* 295; Gosse, *Mar. Zool.* 17; Busk, *Mar. Polyz.* ii. p. 85; *Paleont. Soc.* (*foss.*) 1859.

CELLEPO'RIDÆ.—A family of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata.

Char. Those of the single genus *Cellepora.*

CELLULAR TISSUE, OF ANIMALS, sometimes called fibro-cellular, connective, or areolar tissue.

Cellular tissue is very generally diffused throughout the bodies of vertebrate animals, filling up the interspaces between the various organs, and entering into the composition of most of them.

The fibrous variety consists essentially of white fibrous tissue, mostly containing the elements of the yellow or elastic tissue. The most common form of the white fibrous element is that of minute, delicate, transparent fibres, called fibrillæ, with pale outlines (Pl. 40. fig. 41); these are sometimes single, at others united into bundles or fasciculi. The fibres as well as the bundles sometimes pursue a straight course; at others they are elegantly curved and wavy, interlacing in all directions, and leaving larger or smaller areolæ or spaces between them, the larger of which are visible to the naked eye. The fibrillæ are about 1-40,000 to 1-20,000″, and the fasciculi about 1-7000 to 1-3000″ in diameter. In the fasciculi, they are connected by an amorphous, transparent, gelatinous substance. Intermingled with the fibres, are elongate or branched cells (connective corpuscles), or nucleated protoplasts, which may be well examined in the transparent laminæ separating the muscles of a frog's leg. When treated with acetic acid, the fibres swell, become paler, and lose their distinctness, the bundles appearing as if fused into a gelatinous mass (fig. 29. p. 66); and round or elliptical nuclei, with their long axes parallel to the direction of the fibres, are brought to view, as in Pl. 40. fig. 43.

The yellow fibrous tissue occurs in the form of fine or coarser fibres, with dark outlines; these sometimes run straight, at others they are wavy or reticular; at others coiled or forming rings around the bundles of the areolar tissue, or running parallel with and between them, sometimes forming perforated membranes. They are best seen when the tissue has been rendered transparent by the addition of acetic acid. This tissue is not now regarded as distinct, but as a modification of the cellular or connective tissue.

The gelatinous variety forms a soft semitransparent mass, containing rounded spindle-shaped or branched cells, and is met with in the Invertebrata.

The truly cellular form, which is also common among the Invertebrata, consists of round or elongate cells, with but little intercellular substance.

Cellular tissue consists chemically of gelatine, which may be obtained from it in solution by boiling.

The various complex structures into the

composition of which the white fibrous element enters, as the mucous membranes, skin, fatty tissue, &c., are noticed under their respective heads.

Cellular tissue is developed from the embryonic corpuscles. These become elongated and fusiform; sometimes the ends are branched. They unite with each other, and the ends become longitudinally split into the component fibrillæ of the future tissue. The substance of the corpuscles subsequently splits in the same manner. But whether the corpuscle is a solid body or protoplast, or whether it is a true cell, and secondary deposition takes place within it, the deposited substance subsequently splitting to form the fibrils, is not agreed upon. See FIBROUS TISSUES.

BIBL. Kölliker, *Gewebelehre &c.*; Paget, *Report &c., Brit. and For. Med. Rev.* 1842, xiv.; Mulder (and Donders), *Physiol. Chem.*; Todd and Bowman, *Phys. Anat. &c.*; Virchow, *Path. Cellul.*; Frey, *Histologie,* p. 208.

CELLULAR TISSUE, OF PLANTS. See TISSUES, Vegetable.

CELLULA'RIA, Pallas.—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata, and family Cellulariadæ.

Distinguished by the jointed, branched, erect polypidom, with flat, linear branches; the contiguous cells in two or three rows, perforated behind, and more than four between two joints; and the absence of avicularia and vibracula. One British species:

C. Peachii (*Cellularia Peachii,* var. Johnston). Cells narrowed downwards, truncate and somewhat rounded above; usually a small spine at the upper and outer angle; three to five perforations behind; orifice oval, regular; margin somewhat thickened, minutely granular; ovicell globular with a tessellated surface.

C. ciliata (Johnston) = *Bicellaria cil.*; *C. avicularia* = *Bugula avic.*; *C. ternata* = *Menipea tern.*; *C. scruposa* = *Scrupocellaria scrup.*; *C. reptans* = *Canda rept.*; *C. Hookeri* = *Cabarea Hook.*; *C. neritina* = *Bugula ner.*; *C. plumosa* = *Bugula plum.*

BIBL. Busk, *Mar. Polyz.* 20; id. *Ann. Nat. Hist.* 1851, vii. 82.

CELLULA'RIADÆ.—A family of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata.

Distinguished by the branched, erect polypidom, and the flat, linear branches, with the cells in one plane. Genera:

1. *Cellularia.* Cells in two or three rows, contiguous, perforated behind, more than four between two joints; no avicularia nor vibracula.

2. *Menipea.* Cells oblong, narrowed downwards, not perforate; one or two avicularia below the orifice in front.

3. *Scrupocellaria.* Cells with a vibraculum behind, and a sessile avicularium at the upper and outer angle; orifice spinous.

4. *Canda.* Cells with a vibraculum in a notch on the outer side; no avicularium at the upper angle.

BIBL. That of the genera.

CEL'LULOSE.—The proximate principle of which the permanent cell-membranes of plants are always composed, it occurs also in some structures of certain animals, as the mantle of the Tunicata, the skin of the silkworm, the elytra of some insects, the tegument of some crustacea, &c. Its physical characters differ very much in different cases; sometimes it is exceedingly soft, and at once acquires a blue colour with iodine (amyloid?). Usually it becomes blue when soaked in tincture of iodine, dried, and then wetted with water. In other cases it is more dense, and does not become coloured blue with iodine until after treatment with sulphuric acid, when it becomes more or less bright blue (the ordinary test for cellulose). Occasionally this reaction gives a purplish colour. In old, infiltrated, or greatly consolidated cellulose structure, this test gives only a yellow-brown colour; but boiling in nitric acid (for woody tissues) or solution of potash (for epidermal tissues) will generally bring the cellulose into a state in which, if wetted with tincture of iodine, dried, and then wetted with water, it turns blue. The blue colour is produced in some resisting kinds of cellulose by a solution of iodine in chloride of zinc, or by iodide of zinc. (See REAGENTS.) Sulphuric acid dissolves cellulose; solutions of potash and nitric acid do not act so quickly, especially the latter. Sulphuric acid always swells it before dissolving. But the best test for ordinary cellulose is the ammoniuret of copper, which quickly dissolves it. Care must be taken in testing for cellulose with iodine, that no extraneous matter lodges on the preparation; fragments of cotton, blotting-paper, &c., consisting of cellulose, might give rise to error. Minute crystals of iodine precipitated from the tincture will give the object a bluish tint.

BIBL. See AMYLOID and CELL-MEM-

BRANES. Schacht, *Müll. Archiv*, 1851, *Microsc. Journ.* 1852, pp. 34 and 106; Huxley, *Microsc. Journ.* 1852, p. 22; Schmidt (Taylor's *Scientific Memoirs*, v. p. 1); Kölliker and Löwig, *Ann. Sc. Nat.* Zoologie, 1846, p. 193; Virchow, *Compt. Rend.* 1853 (*Ann. Nat. Hist.* xii. p. 482); Busk, *Microsc. Journal*, 1854; Schweitzer, *Chem. Gaz.* xvi. pp. 66, 336; Gmelin, *Handb. d. Chem.* vii. p. 574.

CEMENTS.—These are used for closing the cells in which microscopic objects are placed for preservation, also for fastening pieces of glass to each other, to form cells, &c. Those, the method of making which we have not described, can be procured at any oil-shop.

1. *Asphalt varnish* consists of a solution of asphalt in boiling linseed-oil, or oil of turpentine, or in a mixture of the two.

2. *Black Japan* consists of asphalt, gum anime, amber, linseed-oil, and oil of turpentine.

3. *Brunswick black* consists of asphalt, drying linseed-oil, and oil of turpentine.

4. *Canada Balsam*: *a.* alone; *b.* digested at a gentle heat with sufficient ether to render it slightly more fluid: benzole is sometimes used as a solvent, but it "bubbles" so in drying that it should be avoided.

5. *Electrical cement*—*a.* is made by melting together 5 parts of rosin, 1 part of bees'-wax, and 1 of red ochre. *b.* The addition of 2 parts of Canada balsam renders this cement much more strongly adhesive to glass.

6. *Gold-size* may be prepared by boiling 25 parts of linseed-oil for three hours with 1 part of red lead and $\frac{1}{3}$ of a part of umber; then pour off. Successive portions of a finely powdered mixture of equal parts of white lead and yellow ochre are then added to the oil, being well rubbed and mixed with it, until a tolerably thick liquid is formed; this must be once more thoroughly boiled. It is also sold.

7. *Gutta-percha cement* is made by adding 15 parts of oil of turpentine to 1 part of finely cut-up gutta percha, and dissolving by the aid of a continued heat and stirring. The solution is then strained through a cloth. In the strained solution 1 part of shell-lac is then dissolved by heat and stirring. The application of the heat is continued until a drop of the solution let fall upon a cold surface, becomes nearly hard. It can be rendered thinner by the addition of more oil of turpentine.

8. *Marine glue* consists of caoutchouc and shell-lac dissolved in coal-naphtha by the aid of heat. It is sold by the microscope-makers and those who mount objects.

9. *Sealing-wax varnish.* Prepared by adding enough spirit of wine to cover coarsely powdered sealing-wax, and digesting at a gentle heat.

10. *Shell-lac varnish.* Prepared in the same manner as sealing-wax varnish, shell-lac being substituted for the sealing-wax. 20 drops of castor-oil to the ounce is an improvement.

11. *White hard varnish* consists of gum sandarac dissolved in spirit of wine, and mixed with turpentine varnish.

12. *White lead* mixed with drying linseed-oil, and the addition of oil of turpentine (white paint).

13. *Wheat paste* should have a few drops of some essence, or creosote added to it.

14. *Gum-arabic* dissolved in water, with a small quantity of sugar-candy and a few drops of essence.

The method of using these cements is treated of under PRESERVATION.

The varnishes should be kept in wide-mouthed capped bottles, or in bottles accurately closed by a cork, in the under part of which a camel's hair pencil is inserted.

A black colour may be imparted to any of the varnishes, by mixing them with lamp-black; or any colour, by adding correspondingly coloured sealing-wax.

They should all be old, or kept some time before use.

CENAN'GIUM, Fries.—A genus of Phacidiacei (Ascomycetous Fungi) growing upon dead twigs, bursting through the bark in the form of little cups or hollow papillæ. Tulasne has recently made some interesting observations upon this genus, and shown that the plants present two or even three kinds of reproductive bodies, *asci* with *spores*, and also *spermogonia* and *pycnidia* with *spermatia* and *stylospores*. In *C. Cerasi*, Fr. the pycnidia are minute tubular bodies upon the same stroma as the young cupules or asciferous cups. They have been described as species of *Sphæria* and as imperfect cupules of *C. Cerasi*; but their walls are lined with basidia, producing short-stalked stylospores, which are linear and flexuous, and very large, viz. about 1-500″ long; they exhibit three transverse septa. In this species the pycnidia are found in groups, and sometimes become confluent. In *C. Fraxini*, Tul. (Pl. 20.

fig. 17), the pycnidia contain not only stylospores at the base of the cavity, but around the upper part are found spermatia seated on branched articulated filaments. These organs, however, are not regularly coexistent, but occasionally occur alone in a pycnidium; and sometimes the spermatia occur even in the asciferous cupules. The asci in the cupules of *C. Frangulæ* line the bottom of the cups, and are mixed with paraphyses; each ascus or theca contains four spores. Several other species are common in Britain.

BIBL. Berk. *Hook. Br. Fl.* ii. pt. 2. 211; *Ann. Nat. Hist.* vi. 259, 2 ser. vii. 185; Tulasne, *Ann. des Sc. Nat.* 3 sér. xx. 133, pl. 16.

CENOMY'CE. See CLADONIA.

CEPHALOP'ODA.—An order of Mollusca, containing the Nautilus, the Argonaut, the Octopus, the Cuttle-fish (*Sepia*), &c., with the fossil Belemnites and Ammonites. The cartilage of the cuttle-fish is noticed under CARTILAGE; the dorsal plate or sepiostaire under SHELL.

The chromatophores, or cutaneous pigment-cells, and the cutaneous cellular (areolar) tissue are interesting structures.

BIBL. Siebold, *Vergleich. Anat.* i.; Owen, *Hunterian Lectures*, i., and Todd's *Cycl. Anat. and Phys.*; V. d. Hoeven, *Handb. d. Zoolog.*; Cuvier, *Anim. Kingd.* by Blyth, Mudie, Johnston, Westwood and Carpenter; Forbes and Hanley, *Molluscous Animals*, &c.

CEPHALOS'IPHON.—A doubtful genus of Rotatoria.

C. limnias. On *Ceratophyllum.*

BIBL. Pritchard, *Infus.* p. 670.

CEPHALOT'RICHUM, Fr.—A genus of Dematiei (Hyphomycetous Fungi). *C. curtum* is an extremely minute plant growing upon the leaves of Sedges, with scattered, short, brown, erect filaments, bearing somewhat globular heads composed of tufts of forked or ternate branches, with one or two short acute branchlets, slightly scabrous, bearing smooth spores.

C. caput-medusæ, fig. 346.

BIBL. Berk. *Ann. Nat. Hist.* vi. 432, pl. 12. fig. 13; Corda, *Icones Fung.* i. pl. 5. figs. 253–4.

CERAMIA'CEÆ.—A family of Florideous Algæ. Rose-red or purple sea-weeds (one freshwater?) with a filiform frond, consisting of an articulated, branching filament, composed of a single string of cells, sometimes coated with a stratum of small cells. *Fructification*: 1. *favellæ*; berry-like receptacles, with a membranous coat, containing numerous angular spores; 2. *tetraspores*, attached to the ramuli or more or less immersed in the substance of the branches, scattered; 3. *antheridia*, produced in the same situations as the spores. British genera:

1. *Ptilota.* *Frond* compressed, inarticulate, distichous, pectinato-pinnate. *Favellæ* pedunculate, involucrate.

2. *Microcladia.* *Frond* filiform, inarticulate, dichotomous. *Favellæ* sessile, involucrate.

3. *Ceramium.* *Frond* filiform, articulate, dichotomous; the joints opaque. *Favellæ* sessile, mostly involucrate. *Tetraspores* mostly immersed.

4. *Spyridia.* *Frond* filiform, inarticulate; the branches clothed with minute, setiform, articulated ramelli. *Favellæ* pedunculate, involucrate. *Tetraspores* sessile on the ramelli.

5. *Griffithsia.* *Frond* articulated, dichotomous, or clothed with whorled, dichotomous ramelli, rose-red. *Favellæ* involucrate, sessile or pedunculate. *Tetraspores* sessile, on whorled ramelli.

6. *Wrangelia.* *Frond* articulated, pinnate. *Favellæ* terminal, involucrate, containing tufts of pear-shaped spores. *Tetraspores* sessile, scattered on the ramelli.

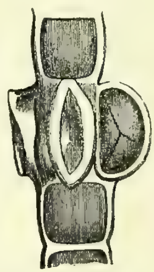
7. *Seirospora.* *Frond* articulated. *Tetraspores* arranged in terminal, moniliform strings.

8. *Callithamnion.* *Frond*, at least the branches and ramuli, articulated, mostly pinnated. *Favellæ* terminal or lateral, sessile, without involucre (except in *C. Turneri*). *Tetraspores* sessile or pedicellate, scattered.

9. *Trentepohlia.* *Frond* articulated, branched, cells in single series. *Favellæ* (?) in terminal corymbs.

BIBL. Harvey, *Man. Brit. Marine Algæ.* See also the Genera.

Fig. 114.



Ceramium Deslongchampsii. Fragment of a frond showing one tetraspore *in situ*, and two empty parent-cells. Magnified 50 diameters.

CERA'MIUM, Roth.—A genus of Ceramiaceæ (Florideous Algæ), containing a number of species, mostly growing between tide-marks, of which *C. ciliatum* is noted as a beautiful object under a low magnifying power. The tetraspores are often only triple, and

arranged tetrahedrally and not in a row (fig. 114).

Bibl. Harvey, *Brit. Mar. Algæ*, pl. 22 C; *Phyc. Britann.* pls. 139–41, &c.

CERATAU'LUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules binate or concatenate; valves turgid, suborbicular or broadly ovoid, with 2 tubular processes alternating with 2 spines. Marine and fossil.

C. turgidus = *Biddulphia turgida*; *C. Smithii* = *Eupodiscus radiatus*; *C. lævis* = *Biddulphia levis*; *C. thermalis.*

Bibl. Ehrenberg, *Ber. d. Berl. Akad.* 1843, 270.

CERATID'IUM, Ehr.—A genus of Infusoria, of the family Oxytrichina.

Char. Furnished with cilia, horns on the fore part of the body, but neither hooks nor styles.

One species, *C. cuneatum.* Dujardin considers this to have been a mutilated *Oxytricha.* The appearance of horns arises from the anterior part of the body being deeply notched.

Bibl. Ehr. *Infus.*; Dujardin, *Infus.* p. 421.

CERA'TIUM.—A genus of Isariacei (Hyphomycetous Fungi) containing a generally diffused British plant, *C. hydnoides*, which grows on rotten wood as a tuft of white simple or slightly branched prickle-like processes, which produce on their surface sterigmata (spicules, *Berk.*), each of which is surmounted by a spore which easily falls off. The whole plant readily collapses into a mucilaginous mass. The cellular appearance figured by Greville depends on the collapsing of the processes.

Bibl. Berk. *Hook. Br. Flor.* ii. pt. 2. 329; Grev. *Sc. Crypt. Fl.* pl. 168.

CERA'TIUM, Schrank = *Peridinia* with horns. Claparède and Lachmann admit 6 species.

CER'ATODON, Bridel.—A genus of Pottiaceous Mosses.

Bibl. Wilson, *Bryolog. Brit.* p. 83; Berkeley, *Brit. Moss.* p. 274.

CERATONE'IS, Ehr.—A genus of Diatomaceæ.

Smith places the British species in other genera, thus:

C. arcus = *Eunotia arcus*; *C. closterium* = *Nitzschia cl.*; *C. fasciola* = *Gyrosigma* (*Pleurosigma*, Sm.) *fasc.*; *C. gracilis* = *Nitzschia tænia*; *C. longissima* = *Nitzschia birostrata.*

Rabenhorst admits *C. arcus*, *C. amphioxys*, and *C. toxon.*

Bibl. Ehr. *Ber. d. Berlin Ak.* 1839, 1840 *et seq.*; Kütz. *Bacill.* and *Sp. Alg.*; Smith, *Brit. Diat.*; Rabenhorst, *Fl. Alg.* i. p. 76.

CERATOP'TERIS, Brongniart.—A genus of Parkerieous Ferns. Exotic. The inrolled margin of the leaf simulates an indusium.

C. thalictroides (spores), figs. 228–230.

CERCA'RIA, Müll.—Originally a genus of Infusoria, but since shown to consist of the larvæ or nurses of Trematoda, as *Distoma*, &c.

The body is oblong, depressed, changeable; the mouth subterminal, armed or unarmed. Acetabulum subcentral. Tail filiform, simple, attenuate at the apex, deciduous.

They are found parasitically on the body, or within the intestines, liver, ovaries, &c. of Mollusca (*Lymnæus*, *Planorbis*, &c.); and may be obtained by wounding the body in water.

C. furcata (Pl. 42. fig. 32). On *Lymnæus stagnalis*, in autumn; length 1-12''. *C. helicis viviparæ*, in the liver of *Paludina vivipara.* *C. planorbis*, in the ovaries of *Planorbis cornea.*

Diesing describes 12 "species."

Bibl. Diesing, *Syst. Helminth.* i. p. 295; Leuckart, V. d. Hoeven's *Zool.*, Supp., p. 90; Hogg, *Mic. Trans.* 1869, p. 232; Vogt, *Zool. Briefe*, i. p. 201.

CERCO'MONAS, Duj.—A genus of Infusoria, of the family Monadina.

Char. Body rounded or discoidal, tuberculated, with a variable posterior prolongation in the form of a tail, which is longer or shorter and more or less filiform (Pl. 23. figs. 22, 23).

Dujardin remarks that the only absolute difference between the Cercomonads and the Monads consists in the presence of the posterior prolongation, which is formed by the substance of the body becoming agglutinated to the slide, and more or less drawn out so as to form sometimes merely a tubercle, at others an elongated tail, or a filament almost as slender as the anterior filament and susceptible of an oscillating motion; also that he thinks he has frequently seen Monads gradually pass into the state of Cercomonads. See Bodo.

Found in infusions, pool-waters, &c.

C. acuminata (Pl. 23. fig. 22). *C. crassicauda* (Pl. 23. fig. 23). *C. intestinalis*, in typhoid diarrhœa, cholera.

Bibl. Duj. *Infus.* p. 287; Pritchard, *Infus.* p. 497; Perty, *Z. Kennt.* p. 171.

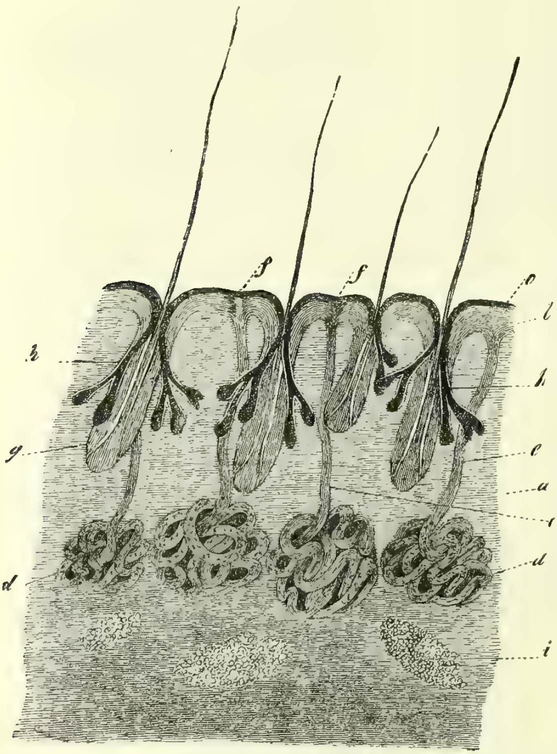
CE'REUS. See Cactaceæ.

CERU'MEN.—The so-called 'wax' of the ear.

Its morphological elements are,—1. Hairs; these exhibit very beautifully the external layer of epidermal scales. 2. Occasionally, the *Demodex folliculorum.* 3. Numerous epidermal scales, mostly compressed, shrunk, or so altered as to resemble fibres, but resolvable into their original form by warming with solution of potash and the subsequent addition of water; by this treatment they are frequently rendered brown, purplish, or almost black. 4. Very numerous cells, filled with pale fatty matter, of a rounded or elongate, flattened, or irregular form; these are derived from the sebaceous follicles. 5. Numerous free oil-globules of the most varied sizes. 6. Yellow or brown granules, and aggregations of them, mostly free, sometimes contained in cells. 7. Various elements derived from without, as fibres of cotton, linen, &c. See CERUMINOUS GLANDS, and CHEMISTRY.

CERU'MINOUS GLANDS.—The glands which secrete the 'wax' of the ear. They are situated in the tube of the ear, or the meatus auditorius externus of anatomists. They closely resemble the sudoriparous ducts in appearance, and exist only in the cartilaginous portion of the passage, where they are situated between the skin and the cartilage, or the fibrous mass which occupies its place. Each consists of a simple tube coiled at one end, so as to form a gland (fig. 115 *d*), the other being continued in the form of a duct (fig. 115 *e*) to the surface of the skin, upon which it opens; occasionally, however, into the upper part of the hair-follicle.

Fig. 115.



Magnified 20 diameters.

Perpendicular section of the meatus auditorius externus. *a*, Corium; *b*, rete mucosum; *o*, epidermis; *d*, ceruminous glands; *e*, their ducts; *f*, their terminal orifices; *g*, hair-follicle; *h*, sebaceous follicles; *i*, fatty tissue.

The glands consist of an external coat of areolar tissue, with scattered, somewhat spindle-shaped nuclei, and very fine nuclear fibres; a layer of smooth, longitudinal, muscular fibres, consisting of short fibre-cells with elongated nuclei; and an inner single layer of epithelium, composed of polygonal cells, from 1-1800 to 1-1100″ in diameter, with roundish nuclei. These cells contain round or irregularly-shaped yellowish-brown granules, of very various sizes, as also globules of oil. The duct has a coat of areolar tissue, and an epithelial coat, consisting of several layers of small nucleated cells, not containing fat or pigment-granules.

CESTODISCUS, Grev.—Frustules disk-shaped, circular or oval; valves with radiating granules, and a submarginal circle of obtuse processes unconnected by special radiating lines of dots with the centre. 4 species.

BIBL. Greville, *Mic. Trans.* 1865, p. 48; 1866, p. 123.

CE'TERACH, Willd.—A genus of Ferns, usually arranged with the ASPLENIEÆ, although there is no true indusium, the place of this being supplied

by scales. *C. officinarum* (*Grammitis* Ceterach), the native species, occurs chiefly in limestone districts.

CETOCH'ILUS.—A genus of Entomostraca (Crustacea), belonging to the order Copepoda, and family Cetochilidæ.

Distinguished by the two small styliform appendages to the head; the inferior antennæ being two-branched, the branches nearly equal; the unbranched jaw-feet; the six-jointed thorax, and four-jointed abdomen; and the last pair of legs being formed like the rest. Marine. One British species:

C. septentrionalis. Bright red; forms part of the food of the whale and various fishes; length 1-10″.

Bibl. Baird, *Brit. Entomos.* p. 233.

CETRA'RIA, Ach.—A genus of Lichens: tribe Cetrariei.

Char. Thallus bright brown, rigid, erect, or ascending, divided into laciniæ, with shining cortical layer. Apothecia dull or bright brown. Spermatia cylindrical.

3 British species: *C. islandica*, the well-known Iceland moss; *C. Delisei*; and *C. aculeata.*

Bibl. Nylander, *Syn.* p. 298; Leighton, *Lichen Flora Gt. Britain*, p. 96.

CETRARIE'I.—A tribe of Lichens; family Lichenacei.

Char. Thallus compressed, fruticulose, or membranously dilated; apothecia on the margins of the laciniæ or lobes.

Genera: *Cetraria* and *Platysma.*

CEUTHO'SPORA, Fr.—A genus of Melanconiei (Coniomycetous Fungi) closely related to *Phoma*, one common species of which (*C. phacidioides*) grows on holly-leaves; another occurs on the Cherry-laurel (*C. Lauri*). It is probable that these are only forms belonging to some Ascomycetous genus.

1. *C. phacidioides*, Grev. 3–5 cells in the stroma, splitting into 3–5 plain short teeth.

2. *C. Lauri*, Sow. Unilocular, splitting into 3–4 acute teeth.

Bibl. Berk. *Hook. Br. Fl.* ii. pt. 2. p. 283; Grev. *Sc. Crypt. Fl.* pl. 253, 254.

CHÆTO'CEROS, Ehr.—A genus of Diatomaceæ.

Char. Frustules concatenate; valves equal, subcylindrical, with two processes, one on each side, which, in the young state, are very short and tubular, forming very long horns as the frustules become older; horns subsequently converted into very long, thin and interwoven siliceous filaments. Marine and fossil.

Somewhat allied to *Biddulphia.* Rabenhorst admits 18 species. *C. didymus* (Pl. 41. fig. 47). Some British.

Bibl. Ehrenb. *Ber. d. Berl. Akad.* 1844, p. 198; Kützing, *Sp. Alg.* p. 138; Brightwell, *Micr. Journ.* vi. 155; Lauder, *Mic. Trans.* 1864, p. 75; Rabenhorst, *Flor. Alg.* i. p. 321.

CHÆTOCOCCUS, Ktz.—A doubtful genus of Algæ.

Char. Filaments rigid, short, spiniform, arising from a cellular substratum.

C. violaceus, on *Rhizoclonium*; *C. hyalinus*, on *Cladophora.*

Bibl. Rabenhorst, *Flor. Alg.* ii. p. 199.

CHÆTODISCUS, Grev.—A genus of Diatomaceæ.

Char. Frustules disk-shaped; valves circular or oval, with radiating dots and a submarginal circle of obtuse processes unconnected by means of special radiating lines of dots with the centre.

4 species.

Bibl. Greville, *Micr. Trans.* 1865, p. 48; 1866, p. 123.

CHÆTOGLE'NA, Ehr.—A genus of Infusoria, of the family Peridinæa.

Char. Carapace hispid, or studded with rigid spines; no transverse furrow; an eye-spot present; organ of motion a flagelliform filament.

1. *C. Volvocina* (Pl. 23. fig. 24 *a*). Oval, internal substance brownish-green; eye-spot red; length 1-1100″. Aquatic. This appears to be the same as *Trachelomonas Volvocina.* See Trachelomonas.

2. *C. caudata.* Oval, hispid, with a short tail; internal substance green; eye-spot red; margin of carapace urceolate and toothed; length 1-850″; aquatic.

Bibl. Ehr. *Infus.*; id. *Ber. d. Berl. Ak.* 1840, p. 199; Dujardin, *Infus.* p. 239.

CHÆTO'MIUM, Kunze.—A genus of Perisporiacei (Ascomycetous Fungi), having a filamentous mycelium bearing superficial roundish or ovate conceptacles clothed with hairs, finally opening above and containing clavate asci with paraphyses; sporidia simple, ovate. The asci in this genus are very delicate and are readily absorbed, so that frequently there is not a trace of them, and the sporidia seem naked. British species:

1. *C. elatum*, Kunze. Conceptacles subovate, black or brown, more or less crustaceous; sporidia apiculate at each end. Greville, *Sc. Crypt. Fl.* pl. 230. On mouldering straw, old matting, &c. Very common.

2. *C. chartarum*, Ehr. Conceptacles subglobose, black, surrounded by a bright yellow spot; sporidia roundish. On paper.

3. *C. glabrum*, B. On damp straw.

Bibl. Hook. *Br. Fl.* ii. pt. 2. p. 328; Kunze, *Mycolog.* Heft i.; Fries, *Syst. Mycol.* iii. p. 254, 255.

CHÆ'TOMONAS, Ehr.—A genus of Infusoria, of the family Cyclidina.

Char. An oral vibratile organ (whether a flagelliform filament or ring of cilia is uncertain); movement of animal slow, but leaping effected by means of non-vibratile bristles situated upon the body.

In putrid animal and vegetable infusions; in dead bodies of other organisms—*Closteria*, &c.

C. globulus (Pl. 23. fig. 25 *a*). Nearly spherical, ash-coloured, setæ numerous; length 1-2700″.

C. constricta (Pl. 23. fig. 25 *b*). Oblong, constricted in the middle, hyaline, setæ two; length 1-5400″.

Bibl. Ehr. *Infus.* p. 248.

CHÆTOMOR'PHA, Kütz. = Confervæ spec. (Rabenhorst, *Flor. Alg.* iii. p. 327).

CHÆTONO'TUS, Ehr.—A genus of microscopic aquatic animals, placed by Ehrenberg among the Rotatoria (Rotifera), and by Dujardin with the Infusoria.

Ehrenberg places it in the family Ichthydina (which see). Dujardin gives the following characters:

Body oblong, convex, and furnished with hairs or scales above; flat and provided with very minute vibratile cilia beneath; terminated in front by a rounded margin, near which is a distinct mouth; posteriorly bifurcate or terminated by two caudiform processes.

The three or four species are found in fresh water, amongst aquatic plants. Their structure requires further investigation.

Chætonotus larus (Pl. 24. fig. 24). Length 1-710 to 1-220″.

Dujardin appends *Ichthydium*, Ehr., to this genus.

Bibl. Ehr. *Infus.* p. 389; Duj. *Infus.* p. 568; Mecznikow, *Sieb. & Köll. Zeitsch.* 1865 (*Qu. Mic. Journ.* 1866, p. 240).

CHÆTO'PHORA, Schrank.—A genus of Chætophoraceæ (Confervoid Algæ), characterized like *Draparnaldia* by setigerous branched filaments, but differing from the latter by the filaments being imbedded in a gelatinous matrix. The *Chætophoræ* are found in fresh water, forming little green protuberances on stones, sticks, &c., usually bright green. The zoospores are formed singly in the joints, and bear four cilia. The account of the fructification given by Müller (*Flora*, 1842, p. 513) seems to relate to *Coleochæte*. True fruit, however, is figured by Berkeley in *C. pisiformis*, *Gleanings of Brit. Alg.* pl. 1. fig. 1.

The membrane of the filaments is very delicate; and the zoospores appear sometimes to escape by its solution. British species:

1. *C. endiviæfolia*, Ag. Hassall, *Br. Fr. Alg.* pl. 9. figs. 1, 2; Kütz. *Tab. Phyc.* iii. pl. 21. fig. 3. *Ulva incrassata*, *Eng. Bot.* 967. Common in streams.

2. *C. tuberculosa*, Hook. Hass. *l. c.* pl. 9. 7, 8; Kütz. *l. c.* pls. 19 and 21. *Rivularia tuberculosa*, *Eng. Bot.* 2366. Boggy pools.

3. *C. elegans*, Ag. Hass. *l. c.* pl. 9. 3, 4; Kütz. *l. c.* pl. 20. Stagnant pools; common.

4. *C. pisiformis*, Ag. Hass. *l. c.* pl. 9. 5, 6; Greville, *Crypt.* t. 150; Kütz. *l. c.* pl. 18; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. pl. 19. figs. 1–3. Subalpine lakes.

5. *C. dilatata*, Hass. *l. c.* pl. 13. fig. 2.

6. *C. longæva*, Carm. A doubtful species. Hook. *Br. Flora*, vol. ii. pt. 1.

Rabenhorst admits 10 species.

Bibl. As above.

CHÆTOPHORA'CEÆ.—A family of Confervoid Algæ, growing in sea or fresh water, invested with gelatine; either filiform or (a number of filaments being connected together) expanded into gelatinous, branched, definitely-formed or shapeless fronds or masses. Filaments jointed, furnished with bristle-like processes. Fructification consisting of spores and four-ciliated zoospores, formed out of the contents of the articulations.

Synopsis of British Genera.

1. *Draparnaldia.* Filaments free, gelatinous, the primary nearly colourless, bearing tufts of coloured ramuli at the joint; zoospores formed singly in the joints of the ramuli.

2. *Chætophora.* Filaments dichotomously branched, aggregated into shapeless, incrusting or branched, gelatinous fronds, the joints bearing bristle-like branches; zoospores solitary in the articulations; the membranes of the filaments very fugacious.

3. *Coleochæte.* Frond disk-shaped or irregularly expanded, adherent to leaves, &c. of aquatic plants under water, formed of jointed dichotomous filaments radiating from a centre, more or less conjoined late-

rally; the joints producing from the back a slender truncate open tube, from which a long bristle is exserted. Fructification: spores and zoospores formed in the joints.

4. *Ochlochæte.* Frond discoid, appressed; filaments cylindrical, radiating from a centre, irregularly branched, consisting of a single series of cells, each of which is commonly prolonged above into an inarticulate bristle.

Foreign genus. See APHANOCHÆTE, Kütz.

BIBL. See the genera.

CHÆTOP'SIS, Grev.—A genus of Mucedines (Hyphomycetous Fungi) characterized by erect jointed threads, whorled below, above simple and flagelliform, bearing cylindrical spores from the tips of the branchlets. One species only is known, *C. Wauchii.*

BIBL. Grev. *Scotl. Crypt. Fl.* pl. 236; Berkeley, *Outl. Br. Fung.* p. 353.

CHÆTOSPI'RA, Lachmann.—A genus of Infusoria, of the family Bursarina.

Char. Buccal spire supported on a narrow band-like process, at the base of which is the mouth.

C. Mülleri. Shell lageniform, horny. On torn leaves of *Lemna trisulca.*

C. mucicola. Shell gelatinous. Among Algæ.

BIBL. *Ann. Nat. Hist.* 1857, xix. pl. 9. figs. 6 and 7; Claparède and Lachmann, *Infus.* p. 216.

CHÆTOSTRO'MA, Corda. See VOLUTELLA.

CHÆTOTYPH'LA, Ehr.—A genus of Infusoria, of the family Peridinæa.

Char. Carapace (siliceous?) hispid or covered with rigid hairs; no transverse furrow, no eye-spot.

1. *C. armata* (Pl. 23. fig. 26: *a*, side-view; *b*, posterior end view). Ovato-subglobose, rounded at each end, hispid with short setæ, posteriorly a ring of dark prickles; length 1-620″.

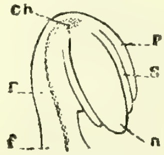
2. *C. aspera* (Pl. 23. fig. 26 *c*). Oblong, rounded at each end, hispid with short setæ; posterior prickles scattered without order; length 1-550″.

3. *C.? pyritæ.* Oblong cylindrical, ends rounded; setæ slender and elongate; no posterior prickles; length 1-1100″, breadth half the length. Fossil in flint. Ehrenberg questions whether this is not a Xanthidium.

BIBL. Ehr. *Infus.* p. 250; Duj. *Infus.* p. 328.

CHALA'ZA (in plants).—The term applied to the base of the nucleus of ovules, where the substance of the former is continuous with the coats, and where the vascular cord derived from the placenta terminates (fig. 116, *ch*).

Fig. 116.



Section of an anatropous ovule: *f*, funiculus; *r*, raphe; *ch*, chalaza; *p*, external coat or testa; *s*, internal coat or tegmen; *n*, nucleus.

CHALCID'IDÆ.—A family of Entomophagous Terebrant Hymenoptera, distinguished by the following characters:—

Head transverse, with the eyes lateral and the face usually bisulcate for the reception of the base of the antennæ (Pl. 44. fig. 8). Antennæ short, frequently thickened at the tips, sometimes branched, composed of not more than thirteen joints, and almost always geniculated at the extremity of the elongated first joint. Palpi very short, sometimes branched. Thorax forming an ovate mass, with a distinct collar. Wings nearly destitute of veins; the anterior with a rather strong subcostal vein running parallel to the anterior margin for about half the length of the wing, and terminating in a stigma, from which a short vein is given off obliquely towards the disk of the wing; the posterior sometimes veinless, sometimes with a short subcostal vein. Legs moderate; hinder thighs sometimes much thickened; tarsi of four or five joints. Abdomen usually composed of seven segments in the males and of six in the females, united to the thorax by a peduncle of variable length; ovipositor usually concealed entirely in a cleft of the lower surface of the abdomen, which extends nearly to the base (fig. 9), but sometimes exserted and very long. The structure of the ovipositor is the same as that of the *Ichneumonidæ.*

The larvæ, like those of the rest of the petiolated Hymenoptera, are footless fleshy grubs (fig. 10). Like the larvæ of the Ichneumonidæ, they usually live in the interior of other insects; but it is remarkable that those of a few species attach themselves to the skin of their victim, and in this position feed upon its substance. The internal feeders generally change to the pupa state

within the pupa of the insect attacked by them; a few, however, break through the skin of the larva and attach themselves to it or to neighbouring objects by a glutinous secretion, or by a small silken cocoon. The pupæ have the limbs more closely attached to the body than in the other Hymenoptera; and in those which have an elongated ovipositor, that organ is turned up over the back. The pupæ are at first whitish, but afterwards become brown or black; they are usually naked (fig. 11).

The family Chalcididæ includes an immense number of parasitic Hymenoptera, the majority of which are of extremely minute size, and adorned with the most brilliant metallic colours. This circumstance, coupled with the delicacy of their form, renders many of the species most beautiful objects; and considering their interesting habits, they certainly do not deserve the almost total neglect which they have met with. The largest species belong to the genus *Leucospis*; but none of these greatly exceed half an inch in length, and they are not found further north than the South of Europe. The thickened hinder thighs which occur in many species of this family, do not always indicate that the insects possessing them are endowed with saltatorial powers; on the other hand, many species which are destitute of thickened thighs leap well; and according to Westwood's observations, this is especially the case with those in which the intermediate tibiæ are furnished with a large spine at the extremity (*Encyrtus*, Pl. 44. fig. 12).

The perfect insects may be met with in abundance during the summer and autumn upon the leaves of trees and plants. They may be taken either by sweeping the herbage with a net, or by beating trees or hedges over a broad net or umbrella.

The sexes are often distinguished in this family by remarkable external characters, especially in the structure of the antennæ. These, in the males of many species, are beautifully branched, in consequence of the joints giving off processes from their sides; in *Eulophus* (fig. 13) we usually find three branches; and in some foreign genera recorded by Westwood the number is increased to five, seven, and even nine. A few species have the wings rudimentary or entirely wanting; and it is remarkable that in some cases the male only is deprived of wings, the female being well furnished with these organs.

The Chalcididæ are parasitic upon insects of nearly all orders, and deposit their eggs in them in all stages of their growth. Some of the minute species even find sufficient nourishment in the eggs of other insects; amongst these we may mention *Pteromalus ovulorum* as a common species, which has been reared from the eggs of Lepidopterous insects. From a single egg of this description Fonscolombe obtained five or six individuals of a minute species, described by him under the name of *Pteromalus atomos.* Westwood also mentions the occurrence of two species of this family in the egg-cases of species of *Mantis* from Brazil and the Isle of France; and Sells has recorded the occurrence of no less than ninety-four specimens of a small *Pteromalus* in a single egg-case of a *Blatta.*

Other minute species deposit their eggs in the bodies of *Aphides*; and their larvæ find a sufficient supply of nourishment even in such small insects as these. Others, especially those forming the genus *Coccophagus* of Westwood, attack the *Coccidæ*, of which they destroy great numbers.

Other species, including most of the larger forms, live parasitically in the cells of the solitary Bees and Wasps. Amongst these we may notice the singular genus *Monodontomerus*, one species of which, first discovered by Audouin, and described by Newport in the 'Linnean Transactions,' is found in the nests of *Odynerus*, *Anthophora*, and *Osmia.* The male of this remarkable insect has only rudimentary wings, so that it is unable to quit the cell of the Bee or Wasp in which it passed its earlier stages, whilst the female, being well provided with wings, can fly about, after impregnation, to seek other nests in which to deposit her eggs.

The species which are furnished with long ovipositors belong chiefly to the genus *Callimome* (fig. 14, *C. cynipis*); they deposit their eggs in different kinds of galls, the vegetable excrescences caused by the puncture of various other insects upon plants. The larvæ of these gallicolous Chalcididæ devour the rightful occupant of the gall.

The instinct which prompts these insects to deposit their eggs in the larvæ of these gall-producing insects, is scarcely so astonishing as that by which others are impelled to insert theirs into the bodies of other parasitic insects, whilst still enclosed within the tissues of their victim. Some of these, such as *Chrysolampus suspensus* and *Coruna clavata*, attack the larvæ of the *Aphidii*,

minute Ichneumons which infest the bodies of Aphides; and De Filippi has recorded the occurrence of the larvæ of one species within a small Dipterous larva which itself lives in the egg of ***Rhynchites Betuleti*** in the vineyards near Turin (Ann. Nat. Hist. 1852, ix. p. 461). De Filippi is inclined to regard the phenomena observed by him as an instance of alternation of generations; but they evidently constitute an example of double parasitism.

BIBL. Westwood, *Introd. to Class. of Insects*, vol. ii.; Spinola, *Ann. du Muséum*, xvii. pp. 138–152; Nees von Esenbeck, *Hymenopt. Ichneum. Monog.* vol. ii.; Boyer de Fonscolombe, *Monog. Chalc. Gallo-Provinciæ*, *Ann. des. Sci. Nat.* xxvi.; Walker, *Monog. Chalcid.*; and papers by Dalman and Boheman in *Kongl. Vet. Akad. Handlingar*; by Walker in *Entom. Mag.* and *Ann. Nat. Hist.*; by Westwood in *Zool. Journ.*, Guérin's *Mag. de Zoologie*, *Entomol. Mag.* &c.; and by Haliday in *Entom. Mag.*

CHA'LIMUS, Burm.—A genus of Crustacea, of the order Siphonostoma, and family Caligidæ.

Char. Fourth pair of legs slender, of only one branch, and serving for walking; frontal plate with a long and slender prehensile appendage arising from the middle of its anterior surface.

C. scombri. Found upon the mackerel, and upon species of *Caligus*, of which it has been supposed to be the young; length about 1-6''.

BIBL. Burmeister, *N.A. Acad. N. C. Bonn*, xvii.; Baird, *Brit. Entomostr.* p. 278.

CHALK.—An earthy form of carbonate of lime, constituting strata of great thickness in England and several parts of Europe, &c. The application of the microscope to the examination of chalk brought to light the interesting fact that this substance has not had its origin in chemical precipitation, since it contains abundance of the inorganic remains of marine animals and plants, principally the former.

Many of these relics are not microscopic, as those of fishes and reptiles, the shells of Malacostracous Crustacea, Mollusca, Echinodermata, the polypidoms of Zoophytes, &c.; hence their consideration does not come within our province: yet it must be remembered that their microscopic structure is characteristic, so that the class, order, or even the more minute division of the animal kingdom to which they belong may be discovered. See BONE and SHELL.

The chief microscopic constituents of the calcareous formations examined by Ehrenberg, viz. chalk, compact limestone, and nummulitic limestone, were found to be shells of Foraminifera, spicules of Sponges, and peculiar bodies called crystalloids; and several siliceo-calcareous earths he found to be wholly composed of spicules, Diatomaceæ, Polycistina, and Foraminifera.

The Foraminifera found by Ehrenberg in the Gravesend chalk are—*Cristellaria cultrata*, *Globigerina cretacea*, *Valvulina pennatula*, *Heterostomella aculeata*, *Nodosaria ovicula*, *Planorbulina ammonoides*, *Polymorphina Thouini*, *Pulvulina Micheliniana*, *Textularia striata*, *gibbosa*, and *agglutinans*, *Vaginulina lævigata* and *longa*, *Verneuilina triquetra*, and *Virgulina Schreibersii* and *Hemprichii*.

M. d'Orbigny enumerates 22 species of Foraminifera from the English chalk; and besides these, others have been found. The genera and subgenera in which they are grouped are—*Bolivina*, BULIMINA, *Cristellaria*, *Dentalina*, *Flabellina*, *Frondicularia*, *Gaudryina*, GLOBIGERINA, *Haplophragmium*, *Heterostomella*, *Lingulina*, LAGENA, LITUOLA, *Marginulina*, MILIOLA, *Nodosaria*, NODOSARINA, *Planularia*, *Planulina*, PLANORBULINA, POLYMORPHINA, PULVINULINA, *Quinqueloculina*, ROTALIA, SPHÆROIDINA, TEXTULARIA, TINOPORUS, *Tritaxia*, *Truncatulina*, VALVULINA, *Verneuilina*, and *Virgulina*.

Two species of Diatomaceæ occur in the English chalk, viz. *Fragilaria capucina* (*F. rhabdosoma*), and *Fr. pinnata*, Ehr. (=*F. mutabilis*, Sm.). Some other Diatomaceæ referred by Ehrenberg to the chalk, belong to totally different beds.

The material of chalk comprises very minute, numerous, and remarkable bodies, called crystalloids and morpholites by Ehrenberg (Pl. 19. fig. 15). They are elliptical, or rounded and flattened, from 1-10,000 to 1-2500'' in length, the most numerous perhaps 1-3000''; some of them consist of a simple ring (*a*); in others this is marked with pretty regular transverse lines, so as to make it appear jointed (*b*); in others, again, there is a thinner central portion, often exhibiting one or more granules (*c*). Ehrenberg regarded these as arising from the disintegration of the microscopic organisms forming the chalk into much more minute calcareous particles, and their reunion into regular elliptical plates (or disks) by a peculiar process, differing essentially from, and

coarser than that of crystallization, but comparable with it,—one probably preceding all *slow* crystalline formation, and causing, but not alone, the granular state of solid inorganic matter. These microscopic bodies have of late years been regarded as the separate or agglomerated plates of very simple protozoan organisms by Huxley, Wallich, and Sorby. By Carter they are believed to form an Alga (Coccoliths).

The best method of examining chalk for minute Foraminifera is this: place a drop of water upon a glass slide, and put into it as much finely scraped chalk as will cover the point of a pen-knife; then diffuse it through the water, and set it aside for a few seconds. Next remove the finest particles which are suspended in the water, together with most of the water, and allow the remainder to become perfectly dry. Moisten this remainder with oil of turpentine, and warm it over a spirit-lamp; then add Canada balsam, and digest it upon the brass table (Intr. xxv.), but without its frothing. A preparation thus made seldom fails; and when magnified 300 diameters, the mass is seen to be chiefly composed of minute well-preserved organisms. As thus prepared, the cells of the Foraminifera first appear black, with a white central spot (Pl. 18. fig. 2), which is caused by air-bubbles contained within the cells. The balsam gradually penetrates into the cells, the black rings of the air-bubbles disappear, and the minute, frequently very elegant cells of the Foraminifera become visible. See Flint, and Foraminifera.

The crystalloids are best examined in common whiting, or powdered chalk which has been shaken with water and set aside. A very minute quantity removed with a dipping tube will exhibit them.

Bibl. The various works on geology, as those of Lyell and Ansted; Mantell, *Wonders &c.*, *Medals of Creation*, and *Ann. Nat. Hist.* 1845, xvi. p. 73 (*Chalk and Flint of S.E. of England*); Bowerbank, *Geol. Trans.* vi.; Ehrenberg, *Abh. d. Berlin. Akad.* 1838 (*Ann. Nat. Hist.* 1841, vii.); id. *Ueb. lebend. Thier. d. Kreid. Abh. d. Berl. Ak.* 1840 (Taylor's *Scientific Memoirs*, iii.), and *Mikrogeologie*, 1854; Williamson, *Manchester Lit. Phil. Soc.* viii. 1847; Morris, *Catal. of British Fossils*, 1854; D'Orbigny, *Mém. Soc. Géol. d. France*, iv. (Weaver's Abs., *Ann. Nat. Hist.* 1841, vii. p. 390).

CHALK-STONES.—This term is vulgarly applied to the white concretions formed around the joints in chronic gout, or, as it is sometimes called, rheumatic gout. They consist of very minute needles of urate of soda (Pl. 8. fig. 12 *b*).

CHAMÆNEMA, Kütz.—A supposed genus of Leptotricheous Algæ, consisting of dusky-coloured jointed filaments, forming flocks in various syrups. Doubtless the mycelia of some Fungi, such as Penicillium.

Bibl. Kützing, *Sp. Alg.* 158.

CHAMÆSIPHON, Br. & Grunow.—A genus of Oscillatoriaceæ.

Char. Fronds erect, simple, parasitic, sheathed, jointed; terminal joints finally separating to form motionless rounded spores. Endochrome æruginous or violet; finely transversely granular.

The 4 species occur upon *Cladophora*, *Calothrix*, *Vaucheria*, &c.

Bibl. Rabenhorst, *Flor. Alg.* ii. p. 148.

CHANTRAN'SIA, Desv. See Trentepohlia (Rabenhorst, *Fl. Alg.* iii. 401).

CHA'RA, L. See Characeæ.

CHARA'CEÆ.—A family of plants generally classed among the Algæ, but which, from the character of their reproductive organs, perhaps demand a more elevated position. They may be placed on the boundary between the Algæ and the Hepaticæ. They are remarkable for their well-known 'circulation,' first discovered by Corti. The Characeæ are aquatic plants, of filamentous structure, exhibiting elongated axes furnished at intervals with whorls of branches (fig. 117). In some species this axis is a simple tube (fig. 124), sometimes a tube with a cortical layer of smaller tubes surrounding it (figs. 118, 119). Some authors have divided the species, on this and some other grounds, into two genera, *Nitella* (simple tubes) and *Chara* (corticated tubes); but according to Al. Braun, who has devoted great attention to this family, the characters will not hold. The mode of ramification of the simple tubes is seen in figs. 124 & 125; that of the compound axes is fundamentally the same, but other cells arise from the branch cells at the articulations, one above and one below each branch (*C. crinita*). Those on the upper side of the branches grow up over the central axis to meet those descending from the under side of the branches of the whorl next above, the ends becoming intercalated about the middle of the internode: in this course of growth cell-division takes place, and the primary cortical tubes are not only made up of many lengths in each internode, but each

is perpendicularly divided into two, one large and one smaller tube (*C. vulgaris*), or produces a secondary tube on each side (*C. aspera*); the primary tubes stand out as ribs from the surface. These cortical tubes describe a spiral course around the internode. Filamentous radical cells are also produced from the whorls. The cells of the main axis and its branches, and the primary cortical cells, are those in which the circulation of the contents may be seen best. The cell-wall is lined by a close layer, like a pavement, of chlorophyl-globules imbedded in colourless protoplasm, arranged in a somewhat spiral order; within them lies a thick layer of semigelatinous consistence (the circulating protoplasm); and the centre is filled up with a watery fluid. The circulation in the ordinary cells consists in the movement of the gelatinous protoplasmic sac, as one mass, slowly up one side of the cell, across the ends, and down the other side,—not perpendicularly, however, but in an oblique or spiral course, as indicated in fig. 125. The fluid in the centre does not circulate, but contains vesicles, granules, or other bodies floating in it, which are free, and when resting upon the protoplasmic sac, are carried along by it and up the side of the cell, until they fall down again by gravitation. The young cells from which the fruits are developed exhibit a circulation of green vesicles; the cortical filaments have a circulating primordial utricle without chlorophyl-globules.

The circulation is obscured in many *Charæ* by the existence of an incrustation of the cell-wall by carbonate of lime, which may often be found in rhomboidal crystals. In *C.* (*Nitella*) *translucens*, *flexilis*, and other species, this does not exist, and these species without cortical tubes exhibit the phenomenon more clearly than the others. Those species, however, which are subject to incrustation have comparatively little about the tips of the shoots; and if they are kept growing for some time in a jar of water pretty free from lime, new shoots may be obtained very suitable for examination. When we carefully examine the conical terminal cell of a shoot, we find the following characters:—The cell-membrane is distinctly laminated, and thickened at the conical apex of the cell; when sulphuric acid and iodine are applied, the cell-wall exhibits a thick internal layer of a blue colour, indicating its composition of cellulose, while a thin layer extending all over the outside becomes bright yellow, and thus presents a resemblance to the cuticular layer of the higher plants. The cell-wall is lined by a thin layer of protoplasm, in which are imbedded a vast number of chlorophyl-globules, closely set and arranged spirally, as above stated; a clear line extends

Fig. 117.

Fig. 118.

Fig. 119.

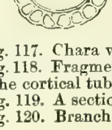


Fig. 120.

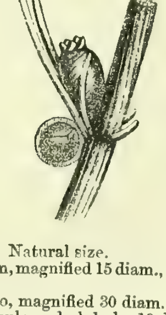


Fig. 117. Chara vulgaris. Natural size.
Fig. 118. Fragment of stem, magnified 15 diam., showing the cortical tubes.
Fig. 119. A section of ditto, magnified 30 diam.
Fig. 120. Branch with nucule and globule, 10 diam.

obliquely up in this layer, bare of chlorophyl. The chlorophyl-globules have much the appearance of vesicles here, and contain starch-corpuscles, which cause the whole layer to turn blue with iodine. (See CHLOROPHYL.) Within this motionless layer is found the thick rotating layer of protoplasm, in which again are imbedded numerous starch and chlorophyl-globules, a vast number of minute granules, and a number of globular bodies of larger size, 1-1500″, according to Göpppert and Cohn covered with rigid cilia. The internal boundary of this layer is wavy and irregular, and thus its rotation carries along, to a certain extent, the watery juice filling up the centre of the cell, in which lie numerous transparent protoplasm-vesicles, ciliated bodies and granular matters.

The fructification of *Chara* is very curious, and its homologies are not yet satisfactorily made out. Upon the branches are found bodies of two kinds (either on the same or on different branches, or on different plants), called the *globule* and the *nucule*. The globule (figs. 119, 121) is regarded as an antheridium: it is a spherical body, of a red or orange-colour when ripe, presenting a transparent thickish outer coat, enclosing an inner wall of curious construction. This is composed of eight triangular plates, each composed of a number of long wedge-shaped cells radiating from a central cell. The plates have dentate margins, by which they fit into one another (fig. 121). The cells contain a red colouring-matter. In the centre of each plate, inside, rises an oblong cell running in toward the centre of the globule, where it meets its fellows from the other plates, and they are united by a little collection of spherical cells; a ninth cell, of similar form but larger size, comes to join these in the centre, it being the pedicle of the globule, arising from the branch upon which it is seated, and entering the globule between the lower four valves. At the point where these nine cells meet in the centre, a number of long septate filaments arise (fig. 122). These are composed, when mature, of a large number of cells placed end to end (figs. 122 & 123), each of which finally discharges a ciliated spiral filament (spermatozoid), which swims actively in the water. The globule bursts, by the separation of its triangular valves, when mature; and it is after this that the spermatozoids are emitted. The form of these spermatozoids is very like that of those found in the Mosses, and different from what is seen in the Ferns, Lycopodiaceæ, &c. (Pl. 32. figs. 31–34).

The *nucule* of the Charæ (figs. 120 & 124), which is regarded by some authors as a pistillidium, is an oval body coated by five cells wound spirally around a central tough sac, the five cells terminating above in five or ten smaller cells, which project like teeth from the summit, forming a kind of crown.

Fig. 121.

Fig. 125.

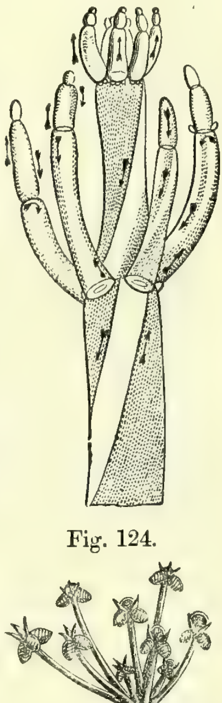


Fig. 122.

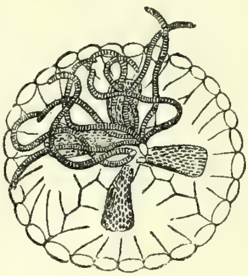


Fig. 124.

Fig. 123.

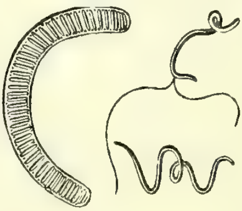


Fig. 121. A globule, magnified 50 diam., showing the triangular valves.

Fig. 122. A globule cut in half, to show the oblong cells and the septate filaments in the centre, 50 diam.

Fig. 123. Portion of a septate filament, 200 diam.; with two biciliated spermatozoids, 400 diam.

Fig. 124. Chara translucens, showing its simple tubes, and nucules grouped in threes under the terminal globule.

Fig. 125. Diagram representing the course of the circulation in the main tube and branches of Chara.

The cells of the crown separate from each other at a particular period, leaving a canal leading down to the central cell, which contains protoplasm, oil, and starch-globules. Ultimately the nucule falls off, germinates, and becomes developed into a new plant. The germinating spore does not, however, directly give origin to the young plant; but, as in the higher Cryptogamia, a prothallus is first formed, and upon this the first branches of the plant are formed by ordinary gemmation.

The *Charæ* also multiply by gemmæ, produced at the articulations of the stem.

Carter has recently published some interesting observations on the development of the root-cells of *Chara*; also an account of the abnormal products which are sometimes found in decaying cells.

BIBL. Corti, *Osserv. &c. sulla Circulazione, &c.* Lucca, 1774; Amici, *Osservazioni sul. Circulaz. &c., Mem. d. Società italiana,* viii. vol. ii. Modena, 1818; *Ann. d. Sc. Nat.* 1824; Dutrochet, *Ann. d. Sc. Nat.* sér. 2. x. 349; Meyen, *Pflanzen-physiologie,* ii. 206; Varley, *Trans. Soc. of Arts,* xlix. 1833; *Micr. Trans.* ii. 93, 1849; Slack, *Trans. Soc. of Arts,* xlix.; Thuret, *Ann. des Sc. Nat.* 2 sér. xiv. 65; 3 sér. xvi. 18; Treviranus. *Physiol. der Gewächse,* i. 1839; Kützing, *Phyc. generalis,* 313; C. Müller, *Botan. Zeitung,* 1845, transl. in *Ann. Nat. Hist.* xvii. 254 *et seq.*; Göppert and Cohn, *Botan. Zeit.* vii. 665 *et seq.* 1849; Al. Braun, *Ber. Berlin.* 1852-3; *Ann. Nat. Hist.* 2 ser. xii. 297; Carter, *Ann. Nat. Hist.* 2 ser. xvi. p. 1, xix. p. 13; Pringsheim, *ibid.* 1862, x. p. 321; Berk. *Suppl. Eng. Bot.* t. 2762.

CHARA'CIUM, Braun.—A genus of Confervoid unicellular Algæ, of doubtful position. Perhaps only male spores of *Œdogonium* and allied genera.

Rabenhorst describes 13 species.

C. Sieboldii (Pl. 45. fig. 2). On filiform Algæ and aquatic mosses.

BIBL. Rabenhorst, *Flor. Alg.* iii. p. 82; Braun, *Alg. Unicell. Gen. nova,* 1855.

CHEESE-MITE. See ACARUS DOMESTICUS.

CHEESE-MOULD. See ASPERGILLUS.

CHEILAN'THES, Sw.—A genus of Adianteæ, nearly related to *Adiantum.* The marginal indusium is very narrow; some species have the under surface of the leaves mealy, from the presence of microscopic hairs.

CHEILO'SCYPHUS, Corda.—A genus of Jungermannieæ (Hepaticæ), founded upon *Jungermannia polyanthus,* L., which is not unfrequent in wet places.

BIBL. Hooker, *Brit. Jungerm.* pl. 62; Corda, in Sturm, *Dtschl. Flor.* ii. 19, 20, p. 35, pl. 9.

CHEILOSTO'MATA.—A suborder of Infundibulate (marine) Polyzoa.

Char. Orifice of cell filled with a thin membranous or calcareous plate, with a curved mouth, furnished with a moveable lip.

It is divided into two sections, containing numerous families and genera.

Tribe 1. *Articulata.* Polypidom jointed.
- Fam. 1. SALICORNARIADÆ. Polypidom erect, cylindrical, dichotomously branched; the cells arranged on all sides.
- Fam. 2. CELLULARIADÆ. Polypidom erect, branches flat, linear, with the cells in the same plane.

Tribe 2. *Inarticulata.* Polypidom unjointed.
- Fam. 3. EUCRATIADÆ (Scrupariadæ). Cells in one row.
- Fam. 4. GEMELLARIADÆ. Cells in pairs, opposite.
- Fam. 5. CABEREADÆ. Branches narrow; cells in two or more rows, with whips or sessile birds' heads at the back.
- Fam. 6. BICELLARIADÆ. As the last, but whips absent, and birds' heads stalked and jointed.
- Fam. 7. FLUSTRADÆ. Polypidom expanded, foliaceous, and flexible.
- Fam. 8. MEMBRANIPORIDÆ. Expanded, incrusting, stony; cells horizontal, quincuncial.
- Fam. 9. CELLEPORIDÆ. Massive, globose, incrusting, or erect, stony; cells vertical to the common plane, irregularly heaped together.
- Fam. 10. ESCHARIDÆ. Expanded and leafy, or branching, stony; cells in the same plane, quincuncial.

BIBL. Johnston, *Brit. Zooph*; Busk, *Cat. Mar. Polyz.* (*Brit. Mus.*); Gosse, *Marine Zool.* i.

CHEIROCEPH'ALUS. See BRANCHIPUS.

CHEIROS'PORA, Fries.—A genus of Melanconiei (Coniomycetous Fungi), growing upon the twigs of the beech. The mycelium spreads under the epidermis, and bursts through in rounded or irregular, conical, black pustules, 1-20″ in diameter, which are composed of a large number of fine filaments, unequal in length, and waved, each terminating in a bunch of spores. The heads are formed of chains of spores like a *Penicillium,*

when young, but crowded together more densely as they become more fully developed into a globular or oval head, about 1-700″; the spores about 1-4000″. This genus corresponds to *Stilbospora*, Montagne, *Myriocephalum*, De Notaris, and, apparently, *Hyperomyxa*, Corda; but the latter is said to have a mucous vesicle enclosing the head.

C. botryospora, Fr. On dead beech twigs, Berk. and Broome, *Ann. Nat. Hist.* 2 ser. v. 455. (Fresenius finds a variety on the hornbeam.)

Bibl. *Cheirospora*, Fries, *Summa Veget.* 508; *Stilbospora*, Fries, *Syst. Mycolog.* iii. 448; Montagne, *Ann. des Sc. Nat.* 2 sér. vi. 338, pl. 18. fig. 5; *Hyperomyxa*, Corda, *Icones Fung.* iii. fig. 78; Montagne, *Ann. des Sc. Nat.* 2 sér. xx. 378; *Myriocephalum*, De Notaris, *Mem. Acad. di Torino*, ser. 2. vii.; Fresenius, *Beitr. zur Mykologie*, p. 39, pl. 5. figs. 1–9 (2tes Heft).

CHELIDO'NIUM, L.—A genus of Papaveraceous plants, remarkable for the yellow juice contained in the laticiferous canals. See Latex.

CHEMICAL REACTIONS.—Introduction, p. xxxviii.

CHEMISTRY.—The following works may be consulted when a more detailed account of the chemical properties of substances is required than that for which we have space in this work.

General works: large.—Berzelius, *Lehrb. d. Chem.*; Gmelin, *Handbuch der Chemie*, (transl. by Cavendish Society); Watts, *Dict. of Chem.*; Graham, *Manual, &c.*; Mitscherlich's *Chemie.*

Small.—Gregory, *Outlines &c*; Lehmann, *Taschenbuch d. Theoret. Chem.*; quite elementary, Stöckhardt, *Experimental Analysis* (Bohn's series). Fresenius, *Anl. z. Chem. Analys.* (translated by Bullock); Will, *Anl. z. Ch. An.* (transl. by Hofmann); Rose, *Analyt. Chem.*

Organic chemistry in general.—Mulder, *Versuch &c.* (transl. by Johnston); Löwig, *Chem. d. Organ. Verb.*; also the above general works.

Animal chemistry.—Simon, *Anthropochemie* (Sydenham Soc.); Lehmann, *Gmelin's Handbuch*, viii.; Robin and Verdeil, *Traité d. Chim. Anat. et Phys.*; Vogel, *Anleit. z. Gebrauche d. Mikr.*; Heintz, *Lehrb. d. Zoochemie*; Scherer, *Chem. und Mikr. Untersuch. &c.*; Höfle, *Chem. und Mikr. am Krankenbette*; Gorup-Besanez, *Zoochem. Analyse*; Schmidt, *Entwurf. ein. allg. Untersuchungsmethode, &c.*; Funke, *Atlas d. Phys. Chemie.*

Vegetable chemistry is treated in the general works.

The progress of chemistry is reported in the *Chemical News.*

CHEY'LETUS, Latreille.—A genus of Arachnida, of the order Acarina, doubtfully referred to the family Trombidina.

Char. Rostrum prominent, palpi thick, resembling arms, and falciform at the ends; antennal forceps (mandibles?) didactylous. Koch describes 6 species.

C. eruditus. Found in books and museums. *Acarus eruditus*, Schrank, *Enum. Insect. Austriæ*, no. 1058; Latreille, *Hist. nat. Crust. et Ins.* viii. 54.

C. marginatus, Koch, copied by Guérin, *Iconogr. Règn. Anim.*, Arach. pl. 5. f. 8.

Bibl. Cuvier, *Règne Animal*, the dateless edition (1853?); Gervais, *Walckenaer's Aptères*, iii.; Koch, *Deutschlands Crustac. &c.*; Robin, *Journ. de l'Anat., &c.* 1867 (figs.), p. 506 (*Qu. Mic. Jn.* 1868); Beck, *Mic. Trans.* 1866, p. 30.

CHICKWEED, *Stellaria media.*—This common plant is of great interest to the microscopic observer, on account of the facility with which the embryo-sac may be dissected out. See Griffith, *Text-book &c.* p. 45, pl. 1.

CHICORY.—This substance, used for mixing with or adulterating coffee, consists of the roots of the plant of the same name (*Cichorium Intybus*). The structures composing the root are recognizable after it has been roasted and ground, consisting of membranous cellular tissue, short-jointed reticulated ducts of large size, and laticiferous tubes. Pure chicory does not appear to contain any starch-granules, this substance being replaced by inuline in most of the plants of this family. The presence of starch, therefore, in samples of chicory denotes adulteration, which, when effected by roasted corn or beans, is easily detected, and the integuments of roasted grain may often be identified. Other common adulterations are roasted carrots, parsnips, or mangel-wurzel; the first of these is difficult to detect, as the structure of the roots is very similar, as is the case to some extent with the parsnip, in which, however, traces of the starch usually remain; the parenchymatous tissue of mangel-wurzel is formed of cells very much larger than those of chicory. In addition to the above, certain substances containing astringent or colour-

ing-matters are occasionally found in ground chicory and coffee—such as oak-bark and tan, mahogany and other kinds of sawdust. These are easily detected by the microscope, from the presence of woody fibre and liber-cells, the origin of which is often to be made out by careful comparative examination.

Bibl. Hassall, *Food and its Adulterations,* pp. 108, 199, 352.

CHI'LODON, Ehr.—A genus of Infusoria, of the family Trachelina.

Char. Body covered with cilia; mouth with teeth arranged in the form of a tube; fore part of the head produced into a broad membranous or ear-like lip.

The cilia form longitudinal rows.

1. *C. cucullulus* (Pl. 23. fig. 27 *a*). Depressed, oblong, colourless, rounded at the ends, slightly auriculate or beaked anteriorly on the right side; aquatic and marine; length 1-1120 to 1-140″. (Pl. 23. fig. 27 *b*, side view.) Contains a red globule (eye-spot?).

2. *C. uncinatus.* Depressed, oblong, rounded at the ends, colourless; narrowed and curved anteriorly so as to appear hooked; aquatic; length 1-430″.

3. *C. aureus.* Ovato-conical, turgid, golden-yellow, anterior end curved so as to form an obtuse beak, posterior end narrowed; aquatic; length 1-140″. A *Nassula* (?).

4. *C. ornatus.* Ovato-cylindrical, golden-yellow, ends rounded, a violet spot at the neck; aquatic and marine; length 1-174″. A *Nassula* (?).

Dujardin admits only the first species; referring the others to the genus *Nassula.*

Bibl. Ehr. *Infus.* p. 336; Duj. *Infus.* p. 490; Stein, *Infus. &c.*; Claparède and Lachmann, *Inf.* p. 335.

CHILO'MONAS, Ehr.—A genus of Infusoria, of the family Monadina.

Char. No tail nor eye-spot; mouth oblique or lateral, and surmounted by a lip; either anterior cilia or one or two (?) very delicate flagelliform filaments present.

1. *C. volvox.* Oval, narrowed and notched in front, colourless and transparent, lip long; aquatic; length 1-1400″.

2. *C. paramecium.* Oblong, keeled, trilateral, colourless and opaque, sometimes aggregated; aquatic; length 1-1020″.

3. *C. destruens.* Oblong, variable in form from its softness, colourless or yellowish; aquatic and marine; length 1-860″.

Dujardin gives different characters: body ovoid-oblong, obliquely notched in front, with a very delicate filament arising from the bottom of the notch; body revolving upon its centre.

4. *C. granulosa* (Pl. 23. fig. 28). Oblong, broader in front, colourless, with granules which appear to project on the surface; length 1-840″. In an infusion of mosses.

5. *C. obliqua.* Ovoid or pyriform, nodular, colourless, variable in form; length 1-2700″.

Bibl. Ehrenb. *Infus.* p. 30; Duj. *Inf.* p. 295.

CHILOSTOMELLA, Reuss.—A Foraminifer.

Bibl. Reuss, *Denkschr. Akad. Wien,* 1850, i. p. 16.

CHIODEC'TON, Ach.—A genus of Lichens (tribe Graphidei), of which one species, C. *myrticola,* has been found in Ireland; and its var. *sarniense* in the Channel Islands.

Bibl. Leighton, *Ang. Lichens,* p. 24, pl. 8. fig. 4, pl. 9. fig. 1; *Lich. Flor. G. B.* p. 404; Tulasne, *Ann. des Sc. Nat.* 3 sér. xviii. pl. 10.

CHIOG'RAPHA, Leight.—A genus of Graphideæ (Gymnocarpous Lichens) separated from *Opegrapha. C. Lyellii = O. Lyellii,* Sm.

Bibl. Leighton, *Ann. Nat. Hist.* 2 ser. xiii. 388, pl. 7. fig. 24.

CHIONY'PHE, Thienem.—A genus of Mucorini (Hyphomycetous Fungi), found growing upon melting snow.

Chionyphe Carteri, Berk., is a curious fungus, which is supposed to be the cause of that formidable disease the Fungus-foot of India. It has, however, been doubted whether it is really the cause, or only a secondary growth on the truffle-like nodules composed principally of stearine (?) which are characteristic of the disease. Jabez Hogg considers the disease somewhat similar to the amyloid lardaceous disease which attacks various other parts of the body.

Bibl. Thieneman, *Nova Acta A. L. C. C.* xi. 1839; *Ann. des Sc. Nat.* 2 sér. xiv. 63; *Intell. Obs.* 1862; Berkeley, *Journ. Linn. Soc.* viii. p. 139; Carter, *Trans. Med. and Phys. Soc. Bombay,* 1861, 1862, 1863; *Ann. Nat. Hist.* vol. ix. p. 442, 1862; *Month. Mic. Journ.* Aug. 1871.

CHIRO'DOTA, Eschsch.—A genus of Echinodermata, closely allied to *Synapta.*

C. violacea possesses curious wheel-like calcareous plates in the skin.

Not British.

Bibl. V. d. Hoeven, *Zool.* i. 150; Carpenter, *On the Microscope,* 564; Herapath, *Qu. Mic. Journ.* 1865, p. 1.

CHITINE is the horny substance which gives firmness to the tegumentary system and other parts of the Crustacea, Arachnida, and Insects; probably also the carapace of the Rotatoria consists of it. It is left when the above structures are exhausted successively with alcohol, ether, water, acetic acid and alkalies, retaining the original form of the texture. It is dissolved by concentrated mineral acids without the production of colour. It is not dissolved by solution of potash, even when boiling. Neither does it give the characteristic reactions with Millon's or Schultze's tests. It contains nitrogen.

Bibl. Odier, *Mém. d. Mus. d'Hist. Nat.* i. p. 35; Lassaigne, *Compt. Rend.* xvi. p. 1087; Schmidt, *Zur Vergl. Phys. d. Wirbellos. Thiere* (Taylor's *Scient. Mem.* v. p. 1); Payen, *Compt. Rend.* xvii. p. 227.

CHLAMIDOCOC'CUS. See Protococcus.

CHLAMID'ODON, Ehr.—A genus of Infusoria, of the family Euplota.

Char. Furnished with cilia and a cylinder of teeth, but neither styles nor hooks. (Oxytricha with a lorica and teeth.)

C. Mnemosyne (Pl. 23. fig. 29). Elliptical, or the anterior end broader, hence ovate; green or colourless, and containing rose-red vesicles; lorica projecting beyond the body; length 1-570 to 1-240″; marine.

Bibl. Ehr. *Infus.* p. 376.

CHLAMIDO'MONAS (Pl. 23. fig. 30 *a*, *b*, *c*, *d*, *e*). See Protococcus.

CHLAMYDOCYSTIS, Grunow, = *Protococcus*, part.

CHLORAS'TER, Ehr.—A genus of Infusoria, of the family Monadina.

Char. Single, mouth (?) terminal, a single frontal eye-spot, no tail, middle of the body with radiate warty processes.

Allied to the genera *Glenomorum* and *Phacelomonas.* Does not admit coloured particles.

C. gyrans. Green, fusiform, acute at the ends; radiate processes in a whorl of four, at first obtuse, then subacute; flagelliform filaments 4–5; length 1-1630″; aquatic.

It revolves rapidly upon its axis, and undergoes spontaneous division.

Bibl. Ehr. *Ber. d. Berl. Akad.* 1848, p. 236.

CHLORATE of Potash. See Potash.

CHLO'REA, Nyl.—A genus of Lichens, family Lichenacei, tribe Usnei.

6 species. *C. vulpina* occurs in Europe.

Bibl. Nyl. *Syn.* p. 274, pl. 8. f. 13–15; Jacq. *Misc.* ii. pl. 10. f. 4.

CHLORIDES. See the bases.

CHLOROCOC'CUM, Grev.—A genus of Palmellaceæ (Confervoid Algæ).

We have assigned to this the common green pulverulent stratum which is found upon every old tree, on all old palings and other exposed woodwork, &c. If this proves to be really a distinct plant, and not an accumulation of germinating gonidia of Lichens (*Lepraria*), it will still differ from the plants we have assembled under the name of *Protococcus,* in its general habit, especially in the absence of zoospores. This point is, however, still open to inquiry, since from recent investigations it appears that the gonidia of the Lichens do divide into two, four and eight, to form a pulverulent stratum, which exactly represents *Chlorococcum* and *Protococcus.*

Chl. vulgare, Grev. (Pl. 3. fig. 1). A collection of extremely minute cells, multiplying by division into twos and fours, no gelatinous substratum, no zoospores. Diameter of single cells 1-3000 to 1-4000″ (*Protococcus viridis,* 1-2000 to 1-3000″). Old dry palings, bark of trees, &c. everywhere. Calculating from the known size of the cells and the wide distribution, this, if a species, would appear to be the most fecund Alga in existence. There are 300 millions of individuals on a square inch, in a layer 1-100″ thick; and such layers clothe almost every piece of unpainted timber and old trunk we meet with in the country. *C. murorum,* Gr. is perhaps a *Palmoglœa,* Kütz.

Rabenhorst describes 12 species; but places *C. vulgare* in the genus *Pleurococcus.*

Bibl. Greville, *Sc. Crypt. Fl.* pl. 262; Hassall, *Br. Fr. Algæ,* pl. 81. fig. 5.

CHLOROGO'NIUM, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. A red eye-spot, a tail, and two anterior filaments. (Not attached by a fixed pedicle.)

C. euchlorum (Pl. 23. fig. 21). Spindle-shaped, acute at each end, tail short; length 1-1150 to 1-280″. Found in enormous numbers in pools and puddles; frequently as many as 10,000 in a single drop.

These organisms do not admit colouring-matter or foreign bodies; hence they are probably not Infusoria, but Algæ. They often adhere to each other in groups by the so-called tails (Pl. 23. fig. 31, upper figure); sometimes to foreign bodies (Pl. 23. fig. 31, lower figure, which exhibits them adhering to a dead *Vorticella*).

They undergo oblique spontaneous divi-

sion (Pl. 41. fig. 1); this commences in the internal substance, which is constricted before the outer portion.

They also propagate by a process of swarming, which takes place thus: the internal substance first separates somewhat from the transparent wall, subsequently becoming irregularly constricted at various parts. The constrictions deepening, the constricted portions separate from each other as independent vesicles (?), and the internal substance acquires the appearance of a blackberry or bunch of grapes, consisting of a fusiform aggregation of uniform longish oval granules. Up to this period, the parent organism continues its movements; subsequently these cease. The granules have now acquired independent vitality, and their filaments become developed. The envelope then breaks near its middle, and the swarm of young ones escape. In their somewhat more developed stage they form *Glenomorum tingens*, Ehr. See PROTOCOCCUS.

BIBL. Ehr. *Infus.* p. 113; Weise, *Wiegmann's Archiv*, 1848, i. p. 65; Stein, *Die Infus.* p. 188 *et seq.*

CHLOR'OPHYLL (leaf-green). — The name applied to the green colouring-matter of plants. The nature of the substances which are understood under this term is still somewhat questionable. It is ordinarily stated that chlorophyll exists commonly under the form of globules or granules, and occasionally as an amorphous granular substance, in either case more or less adherent to, or imbedded in the primordial utricle of the cell. It is, however, a contested point whether the chlorophyll-corpuscles are semisolid homogeneous globules, or vesicles composed of a delicate membrane enclosing a green liquid. Chlorophyll presents itself in the form of distinct corpuscles (*granules* of authors), in the cells of the flowering plants generally, particularly the parenchyma of leaves and the subepidermal parenchyma of green stems and shoots. The granules are especially large and distinct in certain water-plants, and may be well seen lying scattered, singly, imbedded in the circulating protoplasm of the cells of the leaves of *Vallisneria* and other water-plants. The corpuscles are very clear in the cells of the prothallia of Ferns, in the leaves of *Selaginella*, of Mosses and Liverworts; also in *Chara*, where they are very abundant, and form a continuous layer, or else numerous rows, imbedded in a gelatinous stratum between the cell-wall and the circulating mass of protoplasm. In the Confervoids the chlorophyll often appears both formless and corpuscular in one and the same cell, but usually more or less formless in young cells, and more completely converted into granules in the full-grown, as in *Vaucheria*. In the Confervaceæ, such as *Cladophora*, and in *Œdogonium*, it presents itself in a granular stratum with numerous larger bright corpuscles; and in *Spirogyra*, *Zygnema*, &c. the chlorophyll takes the form of the spiral or annular band, to which it is adherent, without large granulations in the general mass, but with a number of distinct, large bright-looking corpuscles at intervals (Pl. 5. fig. 18). In *Protococcus*, in zoospores, and in the individual ciliated bodies of the Volvocineæ, the chlorophyll appears to tinge the general mass of granular protoplasm, leaving the conical apex (beak) uncoloured (Plates 3 & 5), while more or less distinct corpuscles or granules are scattered through the mass, varying in number and size at different periods. When any of these forms of chlorophyll are treated with ether or alcohol, the colour is abstracted, while the organized forms, the corpuscles &c., remain, so that the true chlorophyll is really only a soluble substance, dyeing the bodies called chlorophyll-granules &c. It becomes a question then whether these are homogeneous semisolid corpuscles, or vesicles containing the colouring-matter in sacs, from which it is extracted by the ether &c. Nägeli and others assert the vesicular character of the chlorophyll-corpuscles, and the appearances are sometimes much in favour of this view; but in the many cases in which we have obtained the appearance of a double line around them, under high magnifying powers, we have never been able to divest ourselves of the impression that this was an optical deception. Nägeli asserts that the corpuscles multiply by division, which is probable, but does not prove that they are vesicular structures. The observation, of Göppert and Cohn, of a chlorophyll-corpuscle swelling up and bursting through endosmose, may be explained without supposing a regularly organized coat. We are inclined to believe that the bodies bearing the green colouring-matter are structures belonging to the protoplasm, the green colour being only an additional character, produced by the action of light, superadded to the ordinary character of the granular structures occurring in the protoplasm or nitrogenous cell-contents. See PROTOPLASM.

A very important point connected with chlorophyll is its relation to starch. The bodies called starch-granules occur very commonly with chlorophyll-corpuscles in the cells of the green parts of plants, and they become substituted for each other under varying circumstances. Some authors have imagined that chlorophyll is produced by a chemical decomposition of starch, while others think that starch is developed from chlorophyll. The chief ground for the latter view is the fact that starch-granules (one, or a group of many) are often found in the centre of chlorophyll-corpuscles, like a kind of nucleus. We have traced, in Hepaticæ, the gradual formation of a group of starch-granules in the interior of a chlorophyll-corpuscle (where they are readily detected by the application of iodine); and this goes on in certain cases until almost all the green colour is lost. Starch occurs universally at a certain period in the bright distinct chlorophyll-corpuscles of *Chara* and of the Confervaceæ, *Spirogyra* &c., so that these are coloured blue by iodine, although green before its application. But this starch may disappear again in the course of nature, for it always vanishes from these corpuscles when they are about to become organized into zoospores. In fact the green chlorophyll is predominant during active vegetation, and starch in periods of rest or in full-grown structures. Moreover, while chlorophyll may appear independently in young cells without being preceded by starch, in green tissues: starch makes its appearance without previous existence of chlorophyll-corpuscles in subterraneous structures, as for example in the potato and other tubers. The truth of the matter therefore appears to be, that the chlorophyll-structures, as above stated, are granular structures belonging to the general protoplasm or nitrogenous cell-contents; that they become coloured green in the light by a chemical change connected with the vital processes; that in undergoing this change they do not lose the power, which the ordinary protoplasm possesses, of secreting starch, and decomposing it again when required for the nutrition of the plant. Starch-granules, when free and uncoloured, appear to be produced originally from granular or vesicular protoplasmic structures, only differing by absence of colour from chlorophyll structures. For example, the granular protoplasm around the cell-nucleus in the cells of herbaceous Monocotyledons (such as the Lily, *Tradescantia* &c.) will sometimes become converted into chlorophyll-granules (in superficial cells), inside which starch may be subsequently developed; but (in deeper-seated cells) the granular protoplasm may give rise at once to starch-granules (Pl. 36. fig. 28 *a*) without the previous existence of the green modification of the protoplasm, *i. e.* chlorophyll.

The views of the nature of chlorophyll above expressed (in the first edition of this work) have been since confirmed by the observations of v. Mohl and Gris; and repeated observations have furnished us with similar results. In Caspary's observations on Hydrilleæ also, will be found confirmation of the statement that the supposed vesicular structure is an illusion.

Chlorophyll-corpuscles set free in water expand by imbibing water, sometimes becoming vacuolated and bursting. Alcohol and most acids coagulate them, while acetic acid will often blend the corpuscles into an irregular mass.

Chlorophyll is turned yellow-brown by tincture of iodine; sulphuric acid gives it a more or less deep blue colour; ether and alcohol discharge the green tint. Preparations put up in chloride of calcium or glycerine lose their green colour; those preserved in water will sometimes retain it a long time. The green colouring-matter extracted by alcohol is a complex substance, containing a kind of wax and a matter allied to indigo.

Bibl. Von Mohl, *Veget. Cell.* (*Transl.* 1852), p. 41; *Vermischte Schriften*, p. 349; *Botan. Zeit.* 1855 (*Ann. Nat. Hist.* 2nd ser. xv. p. 321); Nägeli, *Zeitsch. f. Wiss. Bot.* iii. 110 (*Ray Soc.* 1849); Mülder, *Physiol. Chem. Transl.* p. 266; Göppert and Cohn, *Bot. Zeitung*, vii. 665 (1849); Schleiden, *Grundzüge der Wiss. Bot.* 3rd ed. 196; Braun, *Verjüng.* (*Ray Soc.* 1853. p. 195); Morot, *Rech. s. l. color. des Végétaux*, *Ann. des Sc. Nat.* 3 sér. xiii. 160; Guillemin, *Ann. des Sc. Nat.* 4 sér. vii. p. 155; Gris, *ibid.* p. 179; Caspary, *Die Hydrilleæ*, *Pringsheim's Jahrb. der Wiss. Bot.* i. p. 399.

CHLOROPTERIS, Mont.—A genus of Confervoid Algæ, fam. Confervaceæ.

1 species: not British.

CHLOROSPHÆ'RA, Henfrey (Eremosphæra, De Bary).—A genus of Unicellular Algæ, probably related to Œdogonieæ (Rabenhorst places it among the Palmellaceæ), of which one species, *C. Oliveri* (*E. viridis*, De B.) (Pl. 45. fig. 4) is

known, consisting of a single globular cell, about 1-200″ in diameter, densely filled with green contents, sometimes exhibiting a radiated appearance. The cell is multiplied by dividing into two parts by a septum, and forming a new perfect cell in each half, the two new cells escaping through slits in the parent-cell membrane, with elasticity, when mature. Resting-spores, formed in fours in a parent-cell and of a brown colour, have been observed, but not their germination nor any formation of zoospores. The *C. Oliveri* was found in a boggy ditch, at Prestwich Car, Northumberland. It has been found elsewhere in turfy pools.

Bibl. Henfrey, *Mic. Trans.* 1859, vol. vii. p. 25; De Bary, *Conj.* p. 56.

CHLOROTYLIUM, Ktz.—A genus of Confervoid Algæ; family Chætophoraceæ.

Char. Filaments jointed, repeatedly dichotomous, parallel; joints of two kinds, some elongate and colourless, and others swollen, abbreviate, and with green endochromes.

4 species. On rocks, submerged timber, and the bottom of ponds.

Bibl. Kützing, *Sp. Alg.* p. 432; Rabenhorst, *Fl. Alg.* iii. p. 386.

CHOCOLATE. See Cocoa.

CHOIROMYCES.—A genus of Tuberacei (Ascomycetous Fungi) characterized by a definite base, even common integument, clavate asci and spherical sporidia.

C. meandriformis, Vitt., occurs occasionally in Great Britain. It sometimes attains a considerable size.

Bibl. Vitt. *Mon. Tab.* p. 50; *Ann. Nat. Hist.* xviii. p. 80; Sow. *Fung.* t. 310; Tul. *Fung. Hyp.* p. 170, tab. xix. fig. 7.

CHOLERA.—The attempt has often been made to discover some animalcule or minute vegetable organism in the air, water, and the intestinal and other animal liquids, during the existence of cholera, which might explain the origin of this fearful disease; and statements have been published announcing success. None of these have, however, stood the test of rigid investigation. When the cholera prevailed at Berlin in 1832, the renowned Ehrenberg, who had then been engaged in the study of microscopic organisms for many years, declared, after special and careful examination, that neither the air nor the water from various localities, contained any thing unusual. Repeated examinations of the air and water of infected localities, made in 1849, and during the more recent accessions of the cholera, have afforded also conclusive negative evidence.

The view is no less unsupported by reasoning than by fact. Great reproductive power is a general character of the more minute organisms; hence whenever they are present, they are easily recognized. If we examine a silk-worm affected with muscardine, a fly with what may be termed the muscardine of the fly (Sporendonema), a portion of the crust of Favus, or a fragment of an aphthous patch, the parts of the Fungi are present in thousands; there is no need to look for them twice. If they, or their analogues, were present in cholera, the same would surely be the case. There is, further, no reason to believe that Fungi, when growing in animal bodies, ever produce any thing more than a mechanical effect, resulting from their large numbers. The methods of examining the air in regard to this point, are described under Air; and they are far superior to that of simply exposing slides to the atmosphere. The use of glycerine in these experiments must be carefully avoided, on account of its rendering minute and delicate objects so transparent.

Since the above was written, Hallier has attempted to show that it was probably in the first instance derived from a fungus infesting rice. It is, however, a remarkable fact that rice is far less subject to attacks of Fungi than any other cereals. The researches of Thwaites and others have been directed to this especial point, and have in no respect confirmed Hallier's views; added to which, it was quite evident that the fungus which appeared in cholera-evacuations was not the *Urocystis* to which he referred it. De Bary altogether denied the justice of his views. Drs. Lewis and Cunningham were placed by the government authorities in communication with De Bary and Hallier, and quite accorded with the former of the two; and the very careful observations by Dr. Lewis at Calcutta confirm De Bary's views. See Microzymes.

Bibl. Baly and Gull, *Rep. of Cholera Subcommittee of Roy. Coll. Phys., London,* 1849; Robin, *Végét. Parasites, &c.,* 1853, appendice, p. 676; Hallier, *Das Cholera-Contagium*; *Privy Council Report,* 1866; Sansom, *Jn. of Science,* 1871, p. 153; Lewis, *Report on Objects found in Cholera-evacuations*; *Med. Chi. Rev.* 1871.

CHOLERA-FLY.—Knox, *Lancet,* 1853, ii. p. 479.

CHOLES'TERINE. —This substance exists naturally in most animal liquids in a state of solution, also in many animal solids, as in the blood, the bile, the meconium, the brain and spinal cord. As an abnormal product, it occurs in the crystalline form in the bile, biliary calculi, various dropsical effusions, the contents of cysts, pus, old tubercles, malignant tumours, the excrements, expectoration of phthisis, &c.

In the vegetable kingdom it occurs in peas, beans, almonds, many seeds, &c.

The crystals form thin pearly rhombic plates (Pl. 9. fig. 21). The acute angles are $= 79° 30'$, the obtuse $= 100° 30'$. Sometimes the angles are truncated.

Cholesterine is insoluble in water and solution of potash, even when boiling; but soluble in ether and boiling alcohol, crystallizing on cooling.

It is most easily procured from a gallstone by boiling in alcohol; it falls on cooling. The crystals thus obtained are usually thicker than the natural plates.

BIBL. See CHEMISTRY, Animal.

CHONDRACAN'THUS.—A genus of Crustacea, of the order Siphonostoma, and family Lernæopoda.

C. Zei. Found upon the gills of *Zeus* (the common Dory). The body is covered with short reflexed spines. Length 4-5''.

BIBL. Baird, *Brit. Entomostr.* p. 327.

CHONDRIA, Ag. See LAURENCIA.

CHONDRINE.—The gelatinous matter of the permanent true cartilages.

Its solution differs from that of the gelatine of bones &c., in being precipitated by acetic acid, acetate of lead, and alum. The acetic precipitate is insoluble in excess.

It is coloured red by Millon's test; but is unaffected by that of Pettenkofer.

BIBL. See CHEMISTRY, Animal.

CHOND'RUS, L.—A genus of Cryptonemiaceæ (Florideous Algæ), composed of cartilaginous sea-weeds with flat dichotomously-divided fronds, the cellular structure of which exhibits three layers—a central of longitudinal filaments, an intermediate of small roundish cells, and an outer of vertical coloured and beaded rows of cells, the whole imbedded in a tough "intercellular" matrix. See INTERCELLULAR SUBSTANCE.

Fructification: *spores* contained in favellidia immersed in the frond; *tetraspores* collected in imbedded sori; and "*nemathecia*," tubercles composed of radiating filaments (antheridia?). *C. crispus* becomes horny when dry, and is the Irish moss or *Carrageen* of the shops.

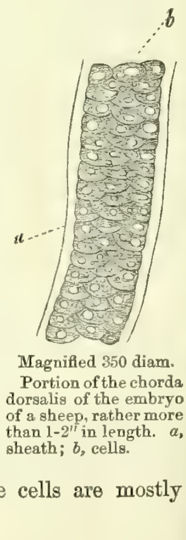
BIBL. Harvey, *Br. Mar. Alg.* pl. 17 D; *Phyc. Brit.* pl. 63 & 187; Greville, *Alg. Brit.* pl. 15.

CHOR'DA, Stackh.—A genus of Laminariaceæ (Fucoid Algæ), with fronds of a peculiar, simple cylindrical form; two species, *C. filum* and *C. lomentaria,* are found between tide-marks on British coasts; the former grows from 1 to 20 or even 40 feet long, with a greatest diameter at half its length, of 1-4 to 1-2''. The cord-like frond is tubular, but has at intervals thin diaphragms, formed by interwoven transparent filaments. The wall of the tube is composed of a number of layers of very regular six-sided cells, upon which are implanted little erect clavate cells which coat the entire surface of the frond. These present two forms, apparently constituting *oosporanges* (*spores,* Harvey, *paranemata,* Ag.) and *trichosporanges* (*antheridia,* Harvey, *spores,* Ag.). The first are single sacs producing a number of zoospores; the second are filaments composed of about five joints, each of which gives birth to a zoospore.

BIBL. Harvey, *Br. Mar. Alg.* 31, pl. 3 B; *Phyc. Brit.* p. 107, &c.; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 240, pl. 29. figs. 5-10; Derbès and Solier, *Ann. des Sc. Nat.* 3 sér. xiv. 268, pl. 33. figs. 7-10; Kützing, *Phyc. gen.* pls. 28 & 29.

CHORDA DORSA'LIS.—The embryonic representative of the spinal column of the Vertebrata; the permanent spinal column of the Cartilaginous Fishes. It sometimes forms a spindle-shaped, transparent, gelatinous-looking cord, with the broadest part near the tail; at others it is cylindrical or conical, rounded anteriorly and tapering posteriorly.

Fig. 126.



Magnified 350 diam.
Portion of the chorda dorsalis of the embryo of a sheep, rather more than 1-2'' in length. *a,* sheath; *b,* cells.

It usually consists of an outer comparatively thick and firm structureless membrane, forming a sheath, and of pale nucleated cells, which fill the sheath (fig. 126). In some instances, however, its structure is fibrous, and that of the sheath fibro-membranous. The cells are mostly

angular or polyhedral, and closely crowded. Their size varies; in the embryo of a sheep rather more than 1-2″ in length, they measured about 1-1800″.

The walls of the cells readily dissolve in solution of potash; but they yield neither gelatine nor chondrine on boiling. The liquid within the cells is not coagulated by boiling, but the chorda itself becomes cloudy and granular.

In its earlier stage of development, the chorda consists simply of a longitudinal band of ordinary formative or embryonic cells; the sheath is subsequently formed. It appears that the spinal column is not developed from the chorda itself, but from a blastema secreted by its component cells and effused around them.

The chorda is most readily examined in the larvæ of frogs (tadpoles), of Tritons, or of Fishes; and may be separated by macerating the dead animals for twenty-four hours in water. On cutting off the tail, it may then be pressed out by gently scraping along its course from the end of the tail, or from the head towards the wound. It is a beautifully delicate structure, and closely resembles in appearance a piece of vegetable cellular tissue.

Bibl. Kölliker, *Mikr. Anat.* ii. p. 346; Schwann, *Ueber die Einstim. &c.* (*Sydenh. Soc.*); Stannius, *Vergl. Anat.*

CHORDA'RIA, Ag.—A genus of Chordariaceæ (Fucoid Algæ), remarkable for the solidity of the cellular texture of the filiform fronds. The axis and branches are composed of a central mass of longitudinal cells, upon which stand horizontal clavate filaments, formed of a row of beaded cells, constituting a distinct peripheral layer, which gives a velvety texture and slimy character to the surface. The so-called spores attached to the horizontal filaments are *oosporanges*, and discharge zoospores when mature; trichosporanges have not yet been observed. *C. flagelliformis*, Müll., is common on rocks and stones between tide-marks.

Bibl. Harvey, *Br. Mar. Alg.* pl. 10 A; *Phyc. Brit.* pl. 111; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. 237.

CHORDARIA'CEÆ.—A family of Fucoid Algæ. Olive-coloured sea-weeds with a gelatinous or cartilaginous, branching frond, composed of vertical and horizontal filaments interlaced together; the oosporanges and trichosporanges attached to the filaments forming the superficial layers of the frond. British genera:

1. *Chordaria.* Axis cartilaginous, dense; filaments of the circumference unbranched.

2. *Mesogloia.* Axis gelatinous, loose; filaments of the circumference branching.

Bibl. Harvey, *Br. Marine Algæ*; Thuret, *Ann. des Sc. Nat.* 3 sér. xvi. p. 5, &c. See also the genera.

CHOROID MEMBRANE. See Eye.

CHROMATE OF LEAD (neutral) is one of the best materials for colouring size in injections. See Injection.

CHROMIC ACID may be prepared by adding gradually from 120 to 150 parts, by volume, of pure concentrated sulphuric acid to 100 parts of a cold saturated solution of bichromate of potash. The crystals of the acid separate as the solution cools. The mother-liquor should be poured off, and the crystals dried upon a tile; they may be purified by re-crystallization from solution in water. With excess of sulphuric acid, chromic acid is a valuable reagent for dissolving the intercellular substance of plants.

Chromic acid is readily decomposed by organic matter, as dust &c., and must therefore be preserved in a well-stoppered bottle. Its aqueous solution, which should be of a pale yellow colour, is used for hardening and preserving nervous and muscular tissues, &c. It should be prepared when required.

CHROOCOC'CUS, Näg. See Protococcus.

CHROOLEPUS, Ag.—A generic name applied to certain byssoid structures found on rocks, bark of trees, &c. *C. aureum* is composed of rigid opaque, ultimately brittle filaments, forming soft cushions of a yellowish colour; *C. Jolithus*, *odoratum*, and *lichenicola* are of orange or fulvous colour. Another series of species, *C. ebenea* &c., are black. These plants have been regarded sometimes as Fungi and sometimes as Algæ.

Rabenhorst describes 11 species: the genus forming the type of the family Chroolepidæ. Reproduction by bi-ciliated zoospores.

Bibl. Hooker, *Brit. Flora,* v. pt. 1. p. 384; *Engl. Bot.* pl. 702 & 1639; Kützing, *Spec. Alg.* p. 425; Caspary, *Flora,* 1858, p. 561; Rabenhorst, *Fl. Alg.* iii. p. 371.

CHRYSALIDI'NA, D'Orb.—A Textularian Foraminifer, with a triserial arrangement of chambers and with large pores, and sometimes tubes, opening from chamber to chamber. *Ch. gradata,* D'Orb., is from the Cretaceous strata of France. A dimorphous form, which is uniserial in its old

state, lives in the Indian ocean and Panama Bay.

Bibl. D'Orbigny, *For. Foss. Vien.* 194; Carpenter, *Introd. Foram.* 193.

CHRYSIME'NIA, J. Ag.—A genus of Laurenciaceæ (Florideous Algæ).

C. clavellosa is a rare sea-weed 3 to 12″ high, forming a feathery frond composed of a branched, tubular, long, not constricted or chambered, cellular structure, filled with a watery juice. The spores are angular, and are contained in dense tufts in ceramidia borne on the sides of the branchlets. The tetraspores are 3-partite and immersed in the branchlets.

Bibl. Harvey, *Br. Mar. Alg.* pl. 13 A; *Phyc. Brit.* pl. 114.

CHTHONOBLAS'TUS, Kütz. See Microcoleus.

CHY'DORUS, Leach (*Lynceus*, Müll., in part).—A genus of Entomostraca, of the order Cladocera, and family Lynceidæ.

Char. Nearly spherical; beak very long and sharp, curved downwards and forwards; inferior antennæ very short.

1. *C. sphæricus* (Pl. 15. fig. 7). Shell smooth; olive-green. Found in ponds and ditches.

2. *C. globosus.* Shell more rounded than in the last, and nearly six times as large; anteriorly reddish, with circular striæ and numerous black spots; aquatic.

Bibl. Baird, *Brit. Entom.* p. 125; Norman and Brady, *Brit. Entom.* pp. 47, 48.

CHYLAQUEOUS or chylo-aqueous liquid and system.

In the Invertebrata, two distinct kinds of nutrient liquids exist. In some classes of this subkingdom, these two liquids coexist in the same organism, though contained in distinct systems of conduits, while in others they become united into one. Williams distinguishes these two kinds of liquid as the *blood proper* or true blood, and the *chylaqueous* liquid. The former is always contained in definitely organized (walled) blood-vessels, and has a determinate circulatory movement; the latter, with equal constancy, in chambers, irregular cavities, and cells communicating invariably with the peritoneal cavity; not having a determinate circulation, but a to-and-fro movement, maintained by muscular and ciliary agency. The true-blood system does not exist under any form, even the most rudimentary, below the Echinodermata; in other words, the true-blood system begins at the Echinodermata. Below the Echinodermata, viz. in the Polypi and Acalephæ, the digestive and circulatory systems are identified, consequently the external medium is admitted directly into the nutrient vessels. This circumstance constitutes a fundamental distinction between the chylaqueous system and that of the true blood, into which, under no conditions, is the external inorganic element directly introduced.

In every class in which the chylaqueous liquid exists, it is charged more or less abundantly with organized corpuscles. These corpuscles are marked by distinctive characters, not in different classes and genera only, but in different species, entitling these bodies to great consideration in the establishment of species. In those classes, as in the Echinodermata, the Entozoa and Annelida, in which, in the adult animal, these two orders of liquids coexist, though distinct, in the same individual, an inverse proportion prevails between them, as respects their magnitude or development. The system of the chylaqueous liquid does not exist in the adult, but only in the larval state of the higher members of the articulated series, as the Myriapoda, Insecta, and the Crustacea.

Bibl. Williams, *Trans. and Proc. of Roy. Soc.* 1852 (the former contains figures of the corpuscles); id. *Ann. Nat. Hist.*, *passim* after 1852; Agassiz, *Sieb. and Köll. Zeitschr.* 1856. vii. 176.

CHYLE.—The chyle consists of a liquid which coagulates when removed from the vessels, containing in suspension molecules, nuclei, colourless corpuscles, and coloured blood-corpuscles.

The *molecules* (Pl. 41. fig. 2 *a*) are very numerous, and probably consist of fatty matter surrounded by a coat of a proteine-compound; to them is owing the milky appearance which the chyle possesses during active digestion. They form the molecular base of Gulliver. The *free nuclei* (Pl. 41. fig. 2 *b*) have a somewhat homogeneous aspect; they are not numerous, about 1-11,000 to 1-5600″ in diameter, frequently appearing cell-like and granular after the addition of water. They are only met with at the origins of the lacteals, in the mesentery, and in the vasa efferentia of the mesenteric glands, but never in the thoracic duct. The *chyle-corpuscles* (Pl. 41. fig. 2 *c*), which are identical with those of the lymph, and the colourless corpuscles of the blood are pale, round, nucleated cells, 1-4500 to 1-2000″ in diameter; their contents become turbid when water is added; and they

are rendered very transparent by the addition of acetic acid, the granular nucleus becoming at the same time very distinct. Sometimes they exhibit a number of Amœba-like processes (Pl. 41. fig. 2 *d*). At the origins of the lacteals the chyle-corpuscles are few in number, or even absent; near the mesenteric glands, they are met with undergoing division. The coloured blood-corpuscles are probably derived from without. Chemically, the chyle consists of a saline liquid, containing albumen and fibrine in solution, the latter when coagulated forming a soft and loose clot.

Bibl. Kölliker, *Mikrosk. Anat.* ii. 561; Wagner, *Handwört.* art. *Chylus*; id. *Elem. of Phys.*, by Willis; Gulliver, *Gerber's Anat.*; Lister, *Dublin Hosp. Gaz.* 1857, 347; Frey, *Histol. &c.* p. 137; and the Bibl. of Chemistry, Animal.

CHYLOCLA'DIA, Grev.—A genus of Laurenciaceæ (Florideous Algæ), containing a few British species, with fronds of small size, composed of a branched, cylindrical and tubular structure, cut off into chambers within by diaphragms at intervals, and filled with a watery juice. The walls are composed of small polygonal cells. Nägeli has given the minute anatomy of *C.* (*Lomentaria*) *kaliformis*. The spores are wedge-shaped, contained in tufts in ceramidia borne on the branchlets. The tetraspores (3-partite) are immersed in the branchlets.

Bibl. Harvey, *Br. Mar. Alg.* pl. 13 B; *Phyc. Brit.* pl. 145, &c.; Grev. *Alg. Brit.* pl. 14; Nägeli, *Algen-systeme*, 246, pl. x. figs. 13–21.

CHYTRID'IUM, Braun.—A genus of Unicellar Algæ, consisting of minute, globose or pyriform, usually colourless cells, operculate at the summit, with a root-like base, attached to Confervoid or allied plants, and penetrating their cell-walls. Zoospores very numerous, globular, with a single very long cilium.

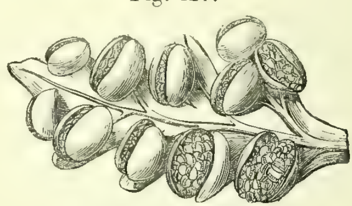
C. olla (Pl. 45. fig. 7).

The commonest form is that of a somewhat ovate cell 1-1500 to 1-2000″ long, sessile by the thick end on the outside of the cell-wall of the plant it infests, and, according to Braun and Cohn, sending fine radical tubes into the interior; the cell-contents of the infested cell are usually found disorganized and discoloured. In another form, distinguished by Pringsheim under the name of *Pythium*, the cells are globular and occur *in* the infested cells, pushing a long tubular neck out through the cell-wall. In both forms the contents of the *Chrytridium*-cell are finally resolved into ciliated gonidia, which escape and swim about. In the external form, the cell often opens by a lid (like the androspore cells of Œdogonium); in the internal form the slender neck opens at the end. Braun has described no less than twenty-three of these obscure bodies, while Rabenhorst admits six species; and they have been observed by Cohn, who connects them with *Achlya*, considering them aquatic fungi. Carter has observed them in *Spirogyra*; and we have found both forms in and on the cells of Chlorosphæra. Braun and Cohn declare them to be really foreign bodies, that is, true parasites; but we are not clear on this point; they seem rather products of diseased protoplasm, if they be not modifications of the antheridial structures of some of the Confervoids.

Bibl. Al. Braun, *Verjüngung &c.* (*Ray Transl.* 1853, p. 185); *Berl. Abhand.* 1855, p. 21 (*plates*); *Ueb. Chytridium*, Berlin, 1856; *Alg. Unicell. Gen. Nov.* Leipsic, 1855; Cohn, *Nova Acta Acad. N. C.* xxiv. pt. 1 (*Qu. Micr. Journ.* iii. p. 208); Bail, *Bot. Zeit.* xiii. 678; Cienkowski, *Bot. Zeit.* xv. p. 233; Carter, *Ann. Nat. Hist.* 2nd ser. xvii. p. 101, and xix. p. 259.

CIBO'TIUM, Kaulfuss.—A genus of Dicksonieæ (Polypodioid Ferns). With a bivalve indusium. Exotic.

Fig. 127.



Cibotium macrocarpum.
A pinnule with sori. Magnified 10 diameters.

CILIA (plural of *cilium*) of Animals.—These are microscopic filaments attached by one end to the surfaces of various parts of animals, and exhibiting a vibratory or rotatory motion. They are usually rounded and broadest at the base, tapering towards the free end; sometimes they are flattened. Their length is very variable, having been estimated at 1-50,000 to 1-500″; probably 1-15,000 to 1-500″ would include most of them. The latter large size is attained by the cilia existing on the point or angle of

the gills or branchial laminæ of the whelk (*Buccinum undatum*).

Numerous examples of animals furnished with cilia, showing their appearance when at rest, are figured in Pls. 23, 24, 25, 34, & 35. During life, and for some time after death, they are usually in constant motion, giving the parts of the field of the microscope in which they are situated a tremulous appearance when their motion is very rapid and the cilia are very minute. When they are large, as on the gills of the common sea-mussel (Mytilus), especially when their motion is slackening, they are seen waving to and fro, or lashing the water, and producing in it strong currents, rendered visible by the motion of minute particles accidentally contained in the water. The motion is mostly uniform, or in one direction; occasionally, however, it has been observed to cease for a moment, and then to assume an opposite direction to that previously exhibited. During the motion, the whole filament is usually more or less curved; but in some instances among the Infusoria, the basal portion of the cilia remains rigid, whilst the terminal portion vibrates; under these circumstances, the cilia are distinguished as flagelliform filaments. Sometimes the cilia move around an imaginary perpendicular axis, in a rotating direction.

Cilia are found in all the Vertebrata and the Invertebrata, excluding the Crustacea, Arachnida, and Insecta. In Man, they spring from epithelial cells; the localities in which they are found are stated under Epithelium.

The uses of the cilia are of two kinds: when the body to which they are attached is of no great bulk or specific gravity compared with that of the medium in which they reside, the cilia become organs of locomotion, as in the Rotatoria, Infusoria, the young Acalephæ, the ovum, &c.; but if the inertia of the body be too great to be overcome by the feeble power of the cilia, they produce motion in the surrounding medium, as on the gills of fishes, of young reptiles, and of the Mollusca, the gill-tufts of the Annulata, and the various mucous surfaces of the Vertebrata upon which they exist, in which they favour respiration and excretion. By the same agency they also bring particles of food suspended in the medium towards the mouth. It need scarcely be remarked, that the motion of cilia must be stronger in one direction than the other, otherwise there could be no current.

The cause of the motion of cilia has long formed a subject for discussion; it is unknown. In some instances, as in the Infusoria, it appears to be voluntary. In some cases it might be attributed to the action of a contractile amorphous tissue, such as that composing the *Amœbæ*. It would naturally be attributed to muscular agency; but no muscular tissue can be detected; in fact, cilia are quite structureless; moreover, they are often of less breadth than the ultimate fibrillæ of muscle. Neither the most powerful poisons, as strychnine, prussic acid, opium and belladonna, nor electricity, produce any effect upon ciliary motion, provided the structure upon which the cilia are situated be not injured. It also lasts a long time after death, having been observed in the lower animals nineteen days after this occurrence, and when putrefaction was far advanced. The question has, however, lost its interest in regard to its necessary dependence upon muscular action, because cilia are common among the lower plants, where this is out of the question.

The cilia and their motion may readily be observed in the common Rotatoria and Infusoria, or in a thin piece cut from the margin of the gills of the oyster or, still better, the sea-mussel; in the latter they form a most beautiful and interesting object. Fresh water almost immediately arrests the motion of the cilia in marine animals. In some cases, solution of potash excites the movement of animal cilia after it has become languid.

The detection of the cilia is frequently of great importance, as the characters of Infusoria, &c. are often based upon their number and arrangement. The means are either indirect—as by the addition of moistened particles of colouring-matters, as indigo, &c. to the living organism, and watching for the movements of the particles—or direct, by examining the structures after the addition of solution of iodine or bichloride of mercury, or drying them at a gentle heat. Both methods should be adopted to check each other: for molecular movement has some resemblance to ciliary motion when feeble, although there is absence of a definite current; and fine hair-like Algæ or Fungi attached to aquatic organisms often resemble cilia, but are deficient in the motion.

See Infusoria; Membranes, undulating; and Molecular motion.

Bibl. Purkinje & Valentin, *Comm. Phys.*

&c.; Sharpey, *Todd's Cycl. of Anat. & Phys.* i. 606; Valentin, *Wagner's Handw. d. Phys. &c.* i. 484; Virchow, *Archiv,* vi. 133.

CILIA of VEGETABLES.—These minute vibratile threads, apparently of the same (unknown) nature as those of animals, are in all cases met with in connexion with the protoplasmic or nitrogenous structures of plants, the structure bearing the closest relation to animal organization. Cilia have as yet been found only in Flowerless Plants, viz. in all the higher or stem-forming Cryptogams, and in the Algæ among the Thallophytes. In the Marsileaceæ, Lycopodiaceæ, Ferns, Equisetaceæ, Mosses, Hepaticæ, and Characeæ, they are found upon the active filaments (spermatozoids) discharged from the antheridia. In the Algæ they occur upon the zoospores and the spermatozoids, and on the fully-developed plants of the family Volvocineæ. They have been stated to occur in certain other complete organisms, as in *Closterium*; but this statement we believe to be erroneous. Rigid filaments bearing some resemblance to cilia occur occasionally upon Diatomaceæ and Oscillatorieæ; but these are not vibratile organs. The mode of arrangement, &c. varies considerably among the cases above cited. In spermatozoids of the Marsileaceæ, Lycopodiaceæ, Ferns, and Equisetaceæ, they are set in considerable number along a filament spirally or heliacally coiled (Pl. 32. fig. 34). In the Muscaceæ, Hepaticæ, and Characeæ, a pair of very long cilia is attached at one end of the filament (fig. 123, p. 145). In zoospores, either they occur in a pair at the apex, as in *Protococcus, Conferva, Cladophora, Codium,* &c., or there are four in the same situation, as in *Ulothrix, Chætophora, Ulva,* &c.,—while the large zoospores of *Œdogonium* bear a crown of vibratile cilia, and the great elliptical zoospore of *Vaucheria* is clothed with them over its whole surface. In the Volvocineæ, there is a pair of cilia attached, just like those of zoospores, to each member of the family of which the compound organism is made up; and these project through orifices in the common envelope, so as to render the perfect plant locomotive, while the cilia of ordinary zoospores disappear when they become encysted in a cellulose coat preparatory to germination. The spermatozoids of the Fucaceæ, and the zoospores produced in the sporangia of other Fucoids have a different arrangement of the cilia: there are always two; but they are attached on a reddish point on the side of the zoospore, not at its apex, and one of the cilia is directed forwards from the apex or beak, while the other trails behind like a kind of rudder.

The mode in which these transitory cilia are lost is variously stated; some authors think they are retracted into the protoplasm; from what we have seen, we believe they are thrown off entire. The cilia have the same chemical reactions as the protoplasmic substances generally, and are apparently processes of it; they are stained brown by iodine, which also stops their motion and renders them partly solid. The mode of detecting and observing cilia is given in the preceding article. Further particulars of individual cases will be found under the heads of the families and genera named above.

BIBL. Thuret, *Rech. sur les Zoospores des Algues, &c., Ann. des Sc. Nat.* 3 sér. xiv. & xvi.; *Sur les Anthéridies des Fougères, Ann. des Sc. Nat.* 3 sér. xi. 5; Hofmeister, *Vergleich. Untersuch., &c.* Leipsic, 1851; Unger, *Die Pflanze im Momente der Thierwerdung,* p. 34, Vienna, 1843; Al. Braun, *Verjüngung, &c.* (*Ray Soc.* 1853); Cohn, *Protococcus pluvialis, Nova Acta A. L. C. C.* xxii. 735 (*Ray Soc.* 1853, p. 352 *et seq.*); on *Stephanosphæra,* Siebold & Kölliker's *Zeitschr.* iv. 77 (*Ann. Nat. Hist.* 2 ser. x. 321 *et seq.*); Henfrey (*Ferns*), *Linn. Trans.* xxi.; Focke, *Physiol. Studien.*

CILIARY PROCESSES. See EYE.

CIMEX, Linn. (Bug).—A genus of Insects, of the order Hemiptera (Heteroptera, Latr., Westw.), and family Cimicidæ.

Char. Antennæ four-jointed; labium three-jointed, the basal joint the longest; thorax sublunate, not transversely divided; abdomen much depressed, and more or less orbicular; elytra reduced to a pair of short, transverse, scale-like pieces; wings none; legs moderately long and slender; tarsi three-jointed.

1. *C. lectularius* (the bed-bug). Ferruginous-ochre; thorax deeply emarginate, its sides reflexed; abdomen suborbiculate, acute at the apex; third joint of antennæ longer than the fourth; rostrum inflected beneath the thorax; labrum short, broad, subovate, trigonate and ciliated.

The common bug has only three setæ, one stouter than the rest, and not toothed or serrated (Pl. 26. fig. 27 *a*), and two others extremely slender and very finely serrated

near the ends (Pl. 26. fig. 27 *b*); they are about 1-20,000″ in breadth at the serrated portion (hence about the 1-20th part of the breadth of the lancets of the flea). The female is larger and more elongated than the male. The eggs (Pl. 31. fig. 20) are white, elongate-oval, elegantly pitted, and terminated by a lid, which breaks off when the young escape. The latter are very small, white and transparent, and have a much broader head, with shorter and thicker antennæ than the mature insect. They are eleven weeks in attaining their full size.

2. *C. columbarius* (Bug of the pigeon). Ferruginous-ochre; thorax deeply emarginate, sides reflexed; abdomen orbicular, subacute at the apex; third joint of antennæ slightly longer than the fourth; length about 1-5″.

3. *C. hirundinis* (Bug of the swallow). Fusco-ferruginous; thorax slightly emarginate; sides flat; abdomen ovate, subacute at apex; antennæ short, third and fourth joints nearly equal; length about 1-7″. Found in swallows' nests.

4. *C. pipistrelli* (Bug of the bat). Ferruginous-ochre, shining; thorax deeply emarginate, sides slightly reflexed; abdomen ovate, posteriorly attenuate; third joint of antennæ longer than the fourth; length 1-6″. On the common bat.

Bibl. De Geer, *Mém.* iii.; Duméril, *Cons. gén. s. l. Ins.*; Westwood, *Introduction, &c.*; id. *Brit. Cycl. Nat. Hist.* i. 640; Jenyns, *Ann. Nat. Hist.* 1839, iii. 241; Curtis, *Brit. Entom.* xii. 569; Landois, *Sieb. & Köll. Zeitsch.* 1868 (*Anat.*) (*Qu. Mic. Jn.* 1868, p. 268).

CINCHONINE. See Alkaloids. Cinchonine is insoluble in ether.

Bibl. See Chemistry.

CINCLID'IUM, Swartz.—A genus of Mniaceæ (operculate Mosses, arranged among the Acrocarpi from prevailing habit), of which one species, *C. stygium*, has been found in Yorkshire.

Bibl. Wilson, *Bryol. Brit.* p. 260; Berkeley, *Brit. Moss.* p. 181.

CINCLIDO'TUS, P. de B. See Guembelia.

CINNAMON.—This consists of the inner part of the bark of *Cinnamomum Zeylanicum* (Lauraceæ); that of Cassia (*C. Cassia*), a coarser and less aromatic substance, is often substituted. These both consist of pitted liber-cells and oil-bearing parenchyma containing starch-granules, and are scarcely distinguishable by the microscope. This instrument, however, enables us to detect the fraudulent extraction of the aromatic oil, since heat applied for this purpose distorts and destroys the characters of the starch-granules. Ground Cinnamon and Cassia are adulterated with flours of different kinds, to increase bulk; these are detected by the characters of their starch-granules.

Bibl. Hassall, *Food and its Adulterations*, p. 399.

CIONISTES, S. T. Wright.—A genus of Hydroid Polypes, fam. Podocorynidæ.

P. reticulata.

Bibl. Hincks, *Brit. Zooph.* p. 134; Wright, *Ann. Nat. Hist.* 1861, viii. p. 123 (fig. 1).

CIRCULAR CRYSTALS.—This term has been applied to the flattened groups of radiating crystalline needles formed by many salts and other crystalline substances. The term, however, is objectionable as tending to obscure their true nature. They form beautiful polarizing objects. Among the most interesting may be mentioned boracic acid, oxalurate of ammonia, salicine, and sulphate of cadmium. They are further noticed under their respective heads. Some of them are figured in Pl. 31. figs. 9–12.

It is interesting to remark that some of these circular crystals, as boracic acid, although belonging to a biaxial system, yet exhibit a single series of coloured rings.

See Ammonia, Oxalurate of, and Polarization.

Bibl. Brewster, *Optics*, 1853, p. 269.

CIRCULATION in Animals.—The movement in a temporarily or permanently definite to-and-fro direction, of the nutritive liquids of animals. We can only enumerate here the articles in which will be found a notice of the circulation, whether true or spurious, as occurring in the most easily accessible or interesting organisms; suffice it to say that circulation is produced either by the agency of muscular or other contractile tissue, or by the action of cilia. Asellus, Arachnida, Entomostraca, Infusoria, Insects (Coccinella, Ephemera, Larvæ, Libellulidæ), Rana, Triton.

CIRCULATION in Plants. See Rotation and Latex.

CIRRIPEDIA or CIRRHOPODA.—An order of Crustacea. The barnacles or acorn-shells.

Char. Marine animals, in the adult state attached to other bodies; enclosed in a multivalved shell or in a coriaceous involucre furnished with calcareous points, the rudiments of a shell; eyes none in the adult state; six pairs of legs, each with a short fleshy peduncle, and two many-jointed horny cirri; mouth furnished with membranoso-corneous mandibles and maxillæ; tail terete, acuminate, reflexed between the legs; body not divided into segments, although there are indications of them in the form of transverse furrows on the dorsal surface. The six pairs of arms or legs which are situated on the ventral surface have each, supported on a short peduncle, two long thin incurved filaments, consisting of numerous joints, and covered with hairs. The animals protrude these filaments incessantly from the orifice of the shell, and retract them, whereby water for respiration, and, with the water, food is brought into the shell. Cirripeds are hermaphrodite.

The young Cirripeds, after leaving the ovum, resemble some of the Entomostraca (*Cyclops*, *Cypris*). They are unattached, and possess eyes.

Bibl. Cuvier, *Mém. du Mus. d'Hist. Nat.* 1815, ii.; Saint-Ange, *Mém. s. l. Cirrip.*; Coldstream, *Todd's Cyclop.*, art. *Cirrhopoda*; Burmeister, *Beit. z. Gesch. d. Rankenfusser*; J. V. Thompson, *Zool. Researches*, and *Phil. Trans.* 1835, p. 355; Darwin, *Monog. of the Cirripedia, Ray Society*, 1851 and 1853; Bibl. of Animal Kingdom.

CLADINA, Nyl.—A subgenus of *Cladonia.*

C. sylvatica, amaurocræa, rangiferina, and *uncialis*, with their varieties, occur in Great Britain.

Bibl. Leighton, *Lich. Fl. G. B.* p. 72.

CLADOBOT'RYUM, Nees. See Dactylium.

CLADODEI.—A series of Lichens (fam. Lichenacei), comprising the tribes Bæomycei, Cladoniei, and Stereocaulei.

CLADO'DIUM, Brid.—A synonym of some species of Bryum.

CLADOGRAMMA, Ehr.—A genus of Diatomaceæ.

Char. Frustules disk-shaped, valves convex, with radiating irregularly forked lines; connecting zone ring-like.

C. californicum, Ehr. *C. conicum*, Grev. Barbadoes deposit.

Bibl. Ehrenberg, *Mikrog.* pl. 33; Greville, *Mic. Trans.* 1865, p. 97.

CLADONEMA, Duj.—A genus of Hydroid Polypes, fam. Stauridiidæ.

C. radiatum. Devonshire coast.

Bibl. Hincks, *Brit. Zooph.* p. 61; Gosse, *Dev. Coast*, p. 257.

CLADO'NIA, Fée.—A genus of Lichens, with a somewhat shrubby thallus, abundant on moors and heaths. It comprises the subgenera *Pycnothelia* and *Cladina.* The Rein-deer Moss (*C. rangiferina*) is common in such localities. 24 other British species.

Bibl. Hook. *Brit. Fl.* ii. pt. 1. 238; *Engl. Bot.* pl. 173, 174, &c.; Leighton, *Lich. Fl. G. B.* p. 54.

CLADONIEI.—A tribe of Lichens, series Cladodei, fam. Lichenacei.

Gen. *Cladonia* and *Pilophoron.*

CLADOPH'ORA, Kütz.—A genus of Confervaceæ (Confervoid Algæ), distinguished by the branched habit of the attached filaments. The *Cladophoræ* are interesting in many respects, in particular for the thick laminated structure of the cell-wall, the special projecting orifice in this by which the zoospores are discharged, the large number of the zoospores, and, lastly, by the favourable opportunity they afford of observing cell-division in the growth of the branched filaments. The filaments are composed of cylindrical cells attached end to end, from which the branches arise by the gradual protrusion of a cylindrical pouch near the upper end, which pouch, becoming shut off by a septum, forms the first cell of the branch. The cellulose wall acquires repeated layers of thickening with age; and longitudinal and transverse striæ may be detected in these by careful management. (See Spiral Structures.) The cellulose wall is lined by a layer of protoplasm (primordial utricle), upon the inside of which lies the chlorophyl, not, however, really imbedded in it, as it is often seen retracted from it in the centre of the cell. At certain periods, numerous starch-granules occur in the mass of chlorophyl; but these disappear when the latter is about to subdivide into zoospores. When this takes place, the whole mass of chlorophyl is contracted from the wall, and becomes broken up, by a kind of segmentation, into a very large number of 2- sometimes 4-ciliated zoospores (these sometimes occur in pairs, through imperfect division). The zoospores, which are produced in all the cells, are discharged through a special papilliform orifice in the cell-wall (Pl. 5. fig. 13); they have a distinct red

spot. Numerous supposed species inhabit fresh, brackish, or sea-water in Britain; some are very common and abundant; but it is difficult to draw out differential characters, as the habit appears to be very variable. They are *Confervæ* of older authors.

C. glomerata, Dillw., is of a dark green colour, and grows commonly in long drawn-out skeins, in pure running water; but it seems to be identical with the rarer *C. ægagropila*, L., which forms dense balls 2 to 4" in diameter, in lakes; while there is also a marine variety.

C. crispata, Sm., is perhaps not distinct; it forms yellowish or dull green strata, everywhere common in fresh water; frequent in brackish water. It is the same as *C. flavescens*, Roth. *C. fracta*, Fl. Dan., is probably a form of this.

The commonest marine species, which are often found in large quantities on the sea-shore, remarkable by their bright green tint, are *C. rupestris*. L., *lætevirens*, Dillw., *albida*, Huds., *lanosa*, Roth., *arcta*, Dillw., and *glaucescens*, Griff.; but some of these, and of the rarer, appear doubtful. The species require a careful study of fresh specimens in all stages. Kützing (*Sp. Alg.*) has made an inextricable mass of confusion of his species. Rabenhorst admits 8 species, with numerous varieties.

Bibl. Hassall, *Br. Fr. Alg.* p. 213, pl. 65–67; Harvey, *Br. Mar. Algæ*, p. 199, pl. 24 D; Thuret, *Rech. sur les Zoosp. &c.*, *Ann. des Sc. Nat.* 3 sér. vol. xiv. p. 10, pl. 16; Al. Braun, *Verjüngung &c.* (*Ray Soc.* 1853) *passim*; Mohl, *Vermischte Schriften*, p. 362, pl. 13; Rabenhorst, *Flor. Alg.* iii. p. 333.

CLADOPHYTUM, Leidy.—Probably the mycelium of a fungus. Found in the intestine of a *Iulus*.

Bibl. See Arthromitus.

CLADOSPORIUM, Link.—A genus of Dematiei (Hyphomycetous Fungi), but stated by Tulasne to be conidiiferous forms of Sphæriacei. *C. herbarum* is one of the commonest moulds; it spreads over the surface as a dense or loose web of confluent tufts of microscopic filaments, straight or curved, more or less varicose, simple or branched; from these arise chains of spores, simple or with one or more septa, round, oval, or longish according to age, and finally becoming detached from one another.

1. *Cl. herbarum*, Lk. Tufts effused, at first green, then black; spores olive; very variable in habit. Everywhere common on decaying substances. Corda, *Ic. Fung.* iii. pl. 1. fig. 24; Fresenius, *Beitr. zur Myk.* pl. 3. fig. 29; *Dematium articulatum*, Sowerby, t. 400. fig. 8.

2. *Cl. dendriticum*, Wallr. On leaves of pear-trees and hawthorn. *C. pyrorum*, Berk. *Gardn. Chron.* 1848, 398. *Helminthosporium pyrorum*, Desmaz. No. 1051. *C. orbiculatum*, Desm. *Ann. des Sc. Nat.* 3 sér. p. 275.

3. *Cl. depressum*, Berk. & Br. On living leaves of Angelica. *Ann. Nat. Hist.* 2 ser. vii. 97, pl. 5. fig. 8.

4. *Cl. brachormium*, Berk. & Br. On leaves of Fumitory. *Ibid.*

5. *Cl. lignicolum*, Corda. On dead wood. Corda, *Icon. Fung.* i. pl. 3. fig. 206.

6. *Cl. nodulosum*, Corda. On stems of herbs. Corda, *Icon. Fung.* i. pl. 4. fig. 212.

CLADOSTEPHUS, Ag.—A genus of Ectocarpaceæ (Fucoid Algæ), containing two common British species, *C. verticillatus* and *C. spongiosus*, which grow on rocks and stones, and form olive tufts a few inches high, composed of rigid irregularly branched cellular axes, clothed by whorls of short, mostly simple, articulated branches. Harvey states that the summer branches contain dark grains in their withered tips, and are deciduous, being replaced in winter by others which bear numerous lateral stalked spores. It is probable these represent respectively the *trichosporangia* and *oosporangia* found in *Ectocarpus*, and that the so-called 'spores' emit zoospores. See Ectocarpus.

Bibl. Harvey, *Br. Mar. Alg.* pl. 9 A; *Phyc. Brit.* pl. 33 and 138.

CLADOTRICHUM, Corda.—A genus of Dematiei (Hyphomycetous Fungi), forming dark flocculent points, or confluent into powdery strata, on dead stumps, &c. The mycelium consists of rigid, much-branched, septate filaments, the upper joints swollen; the spores in chains together at the ends of branches, and bi-, tri-septate, constricted in the middle.

Fig. 128.

Cladotrichum polysporum. Magn. 200 diam.

The species are probably states of Ascomycetous Fungi.

Cl. triseptatum, Berk. and Broome. Spores oblong, very obtuse, with three septa, and constricted opposite the middle

septum. *Ann. Nat. Hist.* ser. 2. vii. p. 98, pl. 5. fig. 7. On a dead stump.

C. polysporum, Corda (fig. 128). Spores biseptate. Corda, *Icon. Fung.* iv. pl. 6. fig. 83; *Prachtflora Eur. Schimmelbild.* (*Polythrincium*, Fries, *Summ. Veg.*)

CLATHROCYS'TIS, Henfrey.—A genus of Palmellaceous Algæ, founded on *Microcystis* (*Polycystis*) *æruginosa* of Kützing. (Pl. 45. fig. 9.) The plants occur in autumn in myriads in freshwater ponds, giving the water a rich grass-green tint; the colour when dry is that of verdigris. Their appearance to the naked eye is that of a mass of green granules suspended in a colourless liquid. Under the microscope each granule is found to be a gelatinous body 1-50 to 1-15″ in diameter, in which are imbedded an infinite number of green cells about 1-8000″ in diameter. The gelatinous masses expand by the multiplication of the green cells in the peripheral stratum, so that they become hollow sacs, the walls of which burst at various points and produce a clathrate structure. The processes of the network ultimately break asunder and commence a new development of the same kind.

BIBL. Henfrey, *Mic. Trans.* new ser. iv. p. 53, pl. 4. figs. 28–36; Currey, *Mic. Jn.* vi. p. 215; Kütz. *Tab. Phyc.* i. pl. 8.

CLATHRULINA, Cien.—A genus of Actinophryina = a stalked *Actinophrys* contained in a fenestrated globular or pyriform carapace. The pseudopodia project through the fenestræ.

2 species or varieties.

BIBL. Cienkowski, *Archiv f. Mik. Anat.* 3. p. 311; *Qu. Mic. Jn.* 1868, p. 31.

CLATHRUS, Mich.—A genus of Gasteromycetous Fungi, fam. Phalloidei.

C. cancellatus, fig. 273.

CLAVA, Gm.—A genus of marine Hydroid Polypes, fam. Clavidæ.

6 British species; height $\frac{1}{4}$ to $1\frac{1}{2}$″.

C. multicornis. Rose-coloured, mouth white; $1\frac{1}{4}$″ high. Common on stones between tide-marks.

BIBL. Hincks, *Brit. Zooph.* p. 1.

CLAVA'RIA, Vaill.—A genus of Clavati (Hymenomycetous Fungi), consisting of variously branched fleshy fungi, growing mostly on the ground, bearing their basidiosporous fructification on the surface of the more or less club-shaped branches. Some species 1″ high, others 1 foot.

BIBL. Hooker, *Br. Flora*, vol. ii. part 2. p. 173.

CLAVATELLA, Hincks.—A genus of Hydroid Polypes, fam. Clavatellidæ.

C. prolifera, British.

BIBL. Hincks, *Brit. Zooph.* p. 70.

CLAVATELLIDÆ.—A family of Hydroid Polypes. 1 genus, *Clavatella.*

BIBL. Hincks, *Brit. Zooph.* p. 69.

CLAVA'TI.—A family of Hymenomycetous Fungi, characterized by bearing basidiospores covering the tip and sides of branched or simple club-shaped or variously cylindrical, compressed, or foliaceous receptacles. See BASIDIOSPORES, HYMENOMYCETES.

CLAVELI'NA, Sav.—A genus of Tunicate Mollusca, of the family Clavelinidæ, under which head the characters are given.

1. *C. lepadiformis.* Thorax a third of the length of the body, lines yellow; length $\frac{1}{2}$ to $\frac{3}{4}$″. On rocks and stones at low water.

2. *C. producta.* Thorax very short, as broad as long, abdomen very long.

3. *C. pumilio.* Nearly sessile and square.

BIBL. That of the family.

CLAVELI'NIDÆ.—A family of Tunicate Mollusca.

Distinguished by the separate bodies arising from a common creeping root-like fibre, and the mantle being united to the test at the orifices only.

These animals are very transparent, and well calculated for the study of the internal structure of the order. Genera:

1. *Clavelina.* Bodies oblong, erect; branchial and anal orifices without rays; thorax marked with coloured lines.

2. *Perophora.* Bodies roundish, compressed; thôrax not marked with coloured lines.

BIBL. Forbes and Hanley, *Brit. Mollusca*, i. 25; Gosse, *Mar. Zool.* i. 35; Lister, *Phil. Trans.* 1834; M. Edwards, *Ascid. Comp.*

CLA'VICEPS, Tulasne.—A genus of Sphæriacei (Ascomycetous Fungi), containing the plants which produce the *ergot* of rye and other grasses. These plants have recently been extricated from great confusion by Tulasne, who appears to have placed their history on a satisfactory basis.

The first sign of the attack upon the flower of a grass is the appearance of a white mould, sometimes accompanied by a honey-like secretion, consisting of minute cells, somewhat after the fashion of the yeast-plant; a swelling (*sphacelia*) then takes place upon the outside of the nascent pistil, which extends to the outer part of the substance of the wall of the ovary,

growing with this until it forms a fungoid mass of the same shape as an ovary, but obliterating the cavity of the latter. At this time it is soft, white, grooved on the surface, and excavated by irregular cavities, which are connected with the external folds or grooves; the surfaces of these are all covered with parallel linear cells, like an hymenium, and from the extremities of these arise elongated ellipsoid or oval cells; about 1-5000″ in length. These become detached, and, when they are placed in water, germinate and emit filaments. These bodies are *spermatia*, *stylospores*, or perhaps *conidia*; they exhibit no motion in water, although they resemble the spermatia of some other fungi. At this time Tulasne calls the structure a *spermogonium.* At a certain epoch a viscid fluid exudes from the *sphacelia*, flowing over it and carrying about multitudes of the *spermatia* or *stylospores*; but previously to this, a solid body, of a violet colour on the surface and white within, has originated at the base of the *spermogonium*, and it gradually grows and rises out of paleæ of the flowers, forming the spur or *ergot.* This is not a metamorphosed seed resulting from diseased conditions, but a real new fungoid structure, the *Sclerotium* of D.C. and others. When this *ergot* is sown in the earth like a seed, it produces a number of little pedicles surmounted by thickened heads, representing stalked *Sphæriæ* (Pl. 20. fig. 18); and on these heads are ultimately found fine points, which indicate the ostioles of little conceptacles (fig. 19). The walls of these conceptacles are lined with asci of elongated clavate form (figs. 20, 21), with linear, slightly clavate paraphyses. These bodies are the *Sphæria purpurea* of Fries, *System. Myc.*

Our space does not admit of further details; but it must be noted that very varied opinions have hitherto prevailed as to the nature of Ergot. Smith and E. Quekett, as also Leveillé, Phœbus, Mougeot, and Fée, regarded the ergot as a mere diseased form of the seed, associated with a parasitic Fungus (*Sphacelia*, Lév., Fée; *Ergotætia*, Quekett).

The *sphacelia* is often accompanied by a Mucedinous fungus which is certainly *not* the result of germination of the stylospores, as might be imagined, but a distinct plant.

Tulasne describes three species:

1. *C. purpurea*, Tul. The ergot of grasses = *Sphæria entomorrhiza*, Schum.; *Sphæria* (*Cordyceps*) *purpurea*, Fries; *Kentrosporium mitratum*, Wallr.; *Sphæropus fungorum*, Guibourt; *Cordyceps purpurea*, Fr.; *Cordyliceps purpurea*, Tulasne. On the flowers of Grasses, such as rye, wheat, oats, and numerous pasture grasses.

2. *C. microcephala*, Tul. *Kentrosporium microcephalum*, Wallr.; *Sphæria microcephala*, Wallr.; *Sphæria acus*, Trog.; *Cordyceps purpurea*, var. *acus*, Desm. On *Phragmites communis* and *Molinia cærulea.*

3. *C. nigricans*, Tul. On species of *Scirpus.*

Bibl. Tulasne, *Ann. des Sc. Nat.* 3 sér. xx. pp. 5–53, pl. 1–4, where all the previous literature is reviewed; Cesati, *Bot. Zeit.* 1855, p. 74; Currey, *Qu. Mic. Jn.* v. p. 132; Bonorden, *Bot. Zeit.* 1858, p. 97; Lindley, *Veg. Kingd.*; Pereira, *Mat. Med.* ii. p. 47.

CLA'VIDÆ. — A family of Hydroid Polypes.

Char. Polypes claviform or fusiform, with scattered tentacula. Genera:

Polypes stalked.	
Stem simple	*Tubiclava.*
Stem much branched	*Cordylophora.*
Polypes sessile.	
Tentacles few	*Turris.*
Tentacles very numerous	*Clava.*

Bibl. Hincks, *Hydr. Zooph.* p. 1.

CLAVULARIA, Grev.—A genus of Diatomaceæ.

Char. Frustules free, linear, with numerous transverse pseudo-dissepiments, interrupted by a central smooth external plate. Valves with a central inflation, and a longitudinal row of short subcapitate processes.

C. Barbadensis (Pl. 42. fig. 33). In Barbadoes deposit.

Bibl. Greville, *Micr. Trans.* 1865, p. 24.

CLAVULI'NA, D'Orb. — A modified *Valvulina*, in which the triserial arrangement of the chambers (three in one whorl of the spire) has passed into a uniserial or linear row, making altogether a *claviform* shell.

The long dimorphous Textulariæ, having a similar shape, have been recorded as *Clavulinæ*; but the absence of the septal *valve* distinguishes them.

C. parisiensis (Pl. 18. fig. 51) is a neat form, with a marked distinction of triserial and uniserial growth. These long dimorphous *Valvulinæ* are common in some Tertiary deposits, and in the Indian and Australian seas.

Bibl. Parker and Jones, *Ann. N. H.* ser. 3. v. 467–469; Carpenter, *Introd. For.* 147, 193.

CLEISTOCAR'PI (Closed-fruited, *i. e.* inoperculate).—An artificial division of the Mosses. See MUSCACEÆ.

CLEN'ODON, Ehr.—A subgenus of Notommata, containing those species which have several teeth in each jaw.

See NOTOMMATA.

CLIMA'CIUM, W. and Mohr.—A genus of Mosses, synonymous with *Hypnum* (*dendroides*).

BIBL. Wilson, *Bryol. Brit.* p. 325; Berkeley, *Brit. Moss.* p. 140.

CLIMACONEIS, Grun.—A genus of Diatomaceæ.

Char. Frustules bacillar, free (?), with 2 scalariform dissepiments; valves striato-punctate, costæ none.

C. Lorenzii. Valves linear-lanceolate, swollen at the ends and the middle. In the Adriatic.

BIBL. Grunow, *Wien. Verhandl.* p. 421, Pl. 8. fig. 7.

CLIMACOSPHE'NIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules cuneate, divided into loculi by transverse septa; valves obovato-lanceolate, with moniliform vittæ in the front view. Marine; not British.

C. australis. Very shortly stipitate; sides of the valves not (very faintly?) striated.

On Algæ from New Holland and South Africa.

C. moniligera (Pl. 19. fig. 9). Stipitate (?); sides of the valves transversely striated (*a*, front view; *b*, side view).

In the Gulf of Mexico.

The nature of the striæ has not been determined.

Rabenhorst enumerates 6 species.

BIBL. Ehrenb. *Abh. Berl. Akad.* 1841, 401; id. *Ber.* 1843; Kützing, *Bacillar.* 123, and *Sp. Alg.* 114.

CLIO'NA, Grant.—A genus of Marine sponges. By means of the spicula imbedded in their surface, they burrow into rocks, shells, and stones.

BIBL. Gosse, *Mar. Zool.* i. 5; Hancock, *Ann. Nat. Hist.* 1849, i. 321; Bowerbank, *Brit. Spong.* ii. p. 212.

CLONOSTA'CHYS, Corda.—A genus of Mucedines (Hyphomycetous Fungi), apparently not distinct from BOTRYTIS.

C. araucaria has been found in England.

BIBL. Corda, *Prachtfl. europ. Schimmelbild.* pl. 15; Currey, *Qu. Mic. Jn.* v. p. 126.

CLOSTE'RIUM, Nitzsch.—A genus of Desmidiaceæ (Confervoid Algæ).

Char. Cells single, elongated, attenuated towards each end, entire; mostly curved lunately or arcuate; junction of the segments marked by a pale transverse band. Endochrome green.

This beautiful genus is of great interest to the scientific microscopic observer. Many of the species are very common, so that scarcely a drop can be taken from the bottom of a clear pool without some of them being contained in it.

Each cell is composed of two equal portions, uniting at a transverse line occupying the middle of the cell. The endochrome exhibits longitudinal bands (Pl. 10. fig. 40), the number varying in different species, of a darker green than the rest of the endochrome (Pl. 10. figs. 40, 41, 43). A number of chlorophyll vesicles are frequently visible in the endochrome, sometimes scattered irregularly, at others arranged in longitudinal series (Pl. 10. fig. 43); at certain periods these contain starch-granules.

The green endochrome is separated from the cell-wall by a stratum of colourless protoplasm which occupies a bluntly triangular space at each extremity. In many cases the protoplasm at these ends exhibits a roundish vacuole, in which a number of minute granules are contained, often in active motion. Similar granules are visible in the marginal line of protoplasm, which exhibits a distinct circulation, requiring a power of about 400 to show it clearly. Focke, Osborne and others have described cilia inside the cell-wall, and attributed the circulation to their action; but this is erroneous. The protoplasm appears to flow up over the cell-wall on all sides, from the centre to the extremity, then to turn round past the vacuole, and return down over the surface of the green endochrome parallel to the upward course.

The *Closteria* are reproduced in various ways. The individuals divide, like the rest of the Desmidiaceæ, the separation taking place transversely in the situation of the transparent space, where two new half-cells become developed, subsequently separating. As these new 'halves' are often very small at the epoch of separation, specimens occur with the two portions very unequal.

Another mode of reproduction is by conjugation. In this, a pair of individuals become united somewhat in the same way as in the Zygnemaceæ; ordinarily the individuals conjugate by the convex side. The process is described as follows:—The outer membranes of the parents split circularly in

the situation of the central transverse space; a delicate internal membrane is protruded from each, as a sac, and these meet and coalesce. Sometimes the sacs are in pairs from each parent-cell. (See CONJUGATION.) When the cross process is complete, the contents of both parent-cells pass into it and become collected into a globular or squarish cell or zygospore (Pl. 10. figs. 42 & 46). Different statements are made with regard to the ultimate history of this, and it is probably variable. Morren states that it becomes a moving gonidium, while most authors state that it becomes a resting-spore with firm membranous coats. Again, Morren assumes the segmentation of the green contents of this spore or gonidium into a number of portions, each of which becomes a perfect individual. Focke gives a figure which seems to bear out this statement, and it would find an analogy in the mode of reproduction by active gonidia in *Pediastrum*, described by Caspary and Braun. (See PEDIASTRUM.) Focke also figures a condition of *Closterium Lunula*, in which the whole of the green contents of an individual cell had become retracted from the walls, and converted into a number of green globular bodies, with proper coats, resembling the resting-spores found in many filamentous Algæ under certain conditions. (See ŒDOGONIUM and SPIROGYRA.)

The *Closteria* are capable of fixing themselves by one extremity to foreign bodies, and Ehrenberg asserted the existence of a foot-like organ; but no such structure seems to exist. The individuals also possess a power of moving in water, but the nature of this is inexplicable at present. The segments of the outer membrane separate from each other when their contents decay, and often when they are dried. The membrane is coloured blue by sulphuric acid and iodine (cellulose); in its natural condition it often has a reddish tint, especially towards the ends.

Rabenhorst describes 52 species, with numerous varieties.

Analysis of ordinary British species:—

1.	Cell suddenly narrowed at the ends into a conical point	*attenuatum*, l. 1-57″.
	Cell not suddenly narrowed	2
2.	Cell striated, tapering into a beak at ends, lower margin prominent at middle	3
	Cell very minute, beaked, straight, not striated, nor lower margin prominent at middle	*Griffithii* *, l. 1-300 to 1-450″.
	Cell not beaked; if striated, lower margin not prominent at middle	6
3.	Beaks setaceous, as long as or longer than body	4
	Beaks linear, much shorter than body	5
4.	Beaks much longer than body	*setaceum* *, l. 1-116″.
	Beaks about as long as body	*rostratum*, l. 1-169″.
5.	Cells much inflated at middle, rapidly tapering at ends	*Ralfsii*, l. 1-79″.
	Cell slightly inflated at middle, gradually tapering at ends	*lineatum*, l. 1-48″.
6.	Cell minute, acicular; sporangium cruciform	7
	Cell not acicular; sporangium orbicular	8
7.	Ends obtuse	*cornu*, l. 1-140″.
	Ends acute	*acutum*, l. 1-177″.
8.	Cell semilunate or semilanceolate, lower margin inclined upwards at ends	9
	Cell with either truncate ends, or lower margin inclined downwards at ends	12
9.	Vesicles numerous, scattered	*lunula* †, l. 1-60″.
	Vesicles in a longitudinal row	10
10.	Ends of cell slightly curved upwards; longitudinal striæ distinct	*turgidum*, l. 1-39″.
	Ends of cell straight; striæ none or indistinct	11
11.	Cell linear-lanceolate; ends conical, obtuse	*acerosum* ‡, l. 1-70 to 1-58″.
	Cell semilanceolate; ends subacute	*lanceolatum*, l. 1-64″.
12.	Cell not striated, crescent-shaped	13
	Cell either not crescent-shaped, or else distinctly striated	17
13.	Vesicles numerous, scattered	*Ehrenbergii*, l. 1-68″.
	Vesicles in longitudinal row	14
	Empty cell colourless, ends rounded	15
14.	Empty cell usually reddish, ends subacute	16
15.	Lower margin of cell inflated at middle	*moniliferum* §, l. 1-75 to 1-60″.
	Cell not inflated at middle	*Jenneri*, l. 1-280″.
16.	Cell inflated at middle	*Leibleinii*, l. 1-90 to 1-60″.
	Cell slender, not inflated at middle	*Dianæ*, l. 1. 140″.
17.	Lower margin of cell inclined upwards at truncate ends; longitudinal striæ none or indistinct	*didymotocum*, l. 1-65″‖.
	Ends of cell inclined downwards; striæ distinct	18
18.	Longitudinal striæ 3 to 7, prominent	19
	Longitudinal striæ numerous, fine	20
19.	Cell semilunar or crescent-shaped	*costatum*, l. 1-75″
	Cell linear	*angustatum*, l. 1-60″.
20.	Cell narrowly linear, nearly straight	*juncidum*, l. 1-69 to 1-111″.
	Cell tapering, curved	21
21.	Longitudinal striæ crowded, sutures 1 to 3	*striolatum*, l. 1-80 to 1-68″.
	Longitudinal striæ not crowded, sutures usually more than 3	*intermedium*, l. 1-77 to 1-54″.

* Pl. 10. figs. 57 & 58.

* Pl. 10. figs. 45 & 46 (Conjugation).
† Pl. 10. fig. 40.
‡ Pl. 10. figs. 41 & 42 (Conjugation).
§ Pl. 10. fig. 43.
‖ Pl. 10. fig. 44.

BIBL. Meneghini, *Syn. Desmid.*, *Linnæa*, xiv. 201 (1840); Ehrenb. *Infus.*; Ralfs, *Brit. Desmidieæ*; Smith, *Ann. Nat. Hist.* 1850, v. 1; Brébisson, *Alg. Falaise, & Conjugatæ*; Kützing, *Spec. Alg.* 163; Berkeley, *Ann. N. Hist.* 2 ser. xiii. 256; Al. Braun, *Rejuv. Ray Soc.* 1853, 289, 292; Morren, *Ann. des Sc. Nat.* 2 sér. v. 257; Focke, *Physiol. Stud.* 1 Heft, 1847; Osborne, *Qu. Mic. Jn.* iii. 54; Henfrey, *Ann. N. Hist.* 3 ser. i. 419; Pritchard, *Infus.* p. 746; Rabenhorst, *Flor. Alg.* iii. p. 123.

CLYPEAS'TER, Lamk.—A genus of Echinodermata.

The hairs or spines springing from the shell are beautiful microscopic objects.

CLY'TIA, Lam.—A genus of Hydroid Polypes, fam. Campanulariidæ.

1 Brit. species: *C. Johnstoni* = *Campanularia volubilis*.

BIBL. Hincks, *Hyd. Zooph.* p. 140.

CNEMIDA'RIA, Presl.—A genus of Cyathæeæ (Polypodiaceous Ferns), with

Fig. 129.

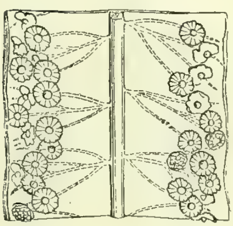


Fig. 130.

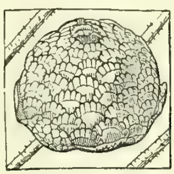
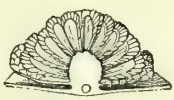


Fig. 131.

Fig. 132.



Cnemidaria horrida.

Fig. 129. Fragment of a pinnule, the sori covered by indusia. Magnified 5 diameters.
Fig. 130. A sorus with indusium destroyed.
Fig. 131. The same, side view, showing the fragment of the indusium at the base.
Fig. 132. Vertical section of a sorus.

Figs. 130–132 magnified 25 diameters.

an indusium bursting irregularly, and leaving the numerous sporanges almost bare. Exotic.

COAL.—This substance, although classed from its mode of occurrence in nature in the mineral kingdom, is in all cases of vegetable origin. The degree, however, in which traces of organic structure may be detected in it varies extremely. Coal may be either tolerably *pure*, containing but slight admixture of earthy matters, or it may contain large quantities of earthy substance, and pass gradually into a carbonaceous impregnation of an earthy basis, as in the various modifications of bituminous shales. In the next place the degree of metamorphosis of the vegetable matter may be equally varied, so that we have it still retaining its structure very evidently, as in *lignites*, &c., or with the structure greatly destroyed, or altogether lost, as in much ordinary coal and anthracite, which however are apparently of somewhat different origin from the more recent lignites. The old coal-beds appear to have been formed from deposits analogous to our peat-bogs, and hence naturally consist in great part of vegetables whose remains soon become undistinguishable; but that arborescent vegetation was also present and contributed to form the coal, seems proved by the detection of woody structure like that of the Coniferæ in certain specimens of coal. Sometimes the woody structure is even evident to the naked eye, in a charcoal-like appearance of the fractured surface of coal. In many lignites the coal consists of trunks of trees converted into coal without much alteration of the appearance of *texture* of the wood; and in these the structure is very readily made out by means of the microscope. Some old coal is largely composed of sporangia of Lycopodiaceous plants. It would be out of place here to enter upon the geological and chemical questions connected with coal; the object of applying the microscope to it is to ascertain the existence or absence of organic structure. For this purpose various methods are employed. That most in use is the preparation of exceedingly thin slices in the manner usually adopted for fossil structures, but the brittle and opaque character of coal opposes great difficulties here. Traces of structure may be made out in some cases by grinding coal to fine powder and examining the fragments; but this plan is very unsatisfactory. A third method is to burn the coal to a white ash, and examine this under the microscope: it often exhibits perfect skeletons of vegetable cells, but these are very fragile, and require great care in

their management. By imbuing them very cautiously with turpentine and Canada balsam, and placing on the covering glass when the latter has become rather firm, permanent preparations may be often obtained. Schulze recommends boiling in nitric acid before incinerating the coal. The method which has been attended with most success in our hands is as follows. The coal is macerated for about a week in a solution of carbonate of potash; at the end of that time it is possible to cut tolerably thin slices with a razor. These slices are then placed in a watch-glass with strong nitric acid, covered and gently heated; they soon turn brownish, then yellow, when the process must be arrested by dropping the whole into a saucer of cold water, or else the coal would be dissolved. The slices thus treated appear of a darkish amber colour, very transparent, and exhibit the structure, when existing, most clearly. We have obtained longitudinal and transverse sections of Coniferous wood from various coals in this way. The specimens are best preserved in glycerine, in cells; we find that spirit renders them opaque, and even Canada balsam has the same defect. Schulze states that he has brought out the cellulose reaction with iodine, in coal treated with nitric acid and chlorate of potash.

The proper identification of vegetable structures in coal must of course depend upon a sufficient knowledge of the characters of vegetable tissues and organisms being possessed by the observer.

Bibl. Witham, *Structure of Fossil Vegetables*, Edinb. 1833; Link, *Abhandl. Berl. Akad.* 1838, p. 34; Göppert, *Preisschrift üb. Steinkohlen,* Leiden, 1848; Lindley and Hutton, *Fossil Flora*; Schleiden and Schmidt, *Geognost. Verhältn. des Saalthales,* Leipzig, 1846; Ehrenberg and Schulze, *Berlin. Ber.* Oct. 1844; F. Schulze, *ibid.* Nov. 1855; *Ann. Nat. Hist.* xvi. p. 69; Bailey (*Anthracite*), *Ann. Nat. Hist.* xviii. p. 67; Unger, *Gen. et Spec. Plant. Foss.* 1850; Carruthers, *Month. Micr. Jn.* ii. pp. 177, 225; iii. p. 144; Williamson, *ibid.* ii. p. 66; Lyell, *Princip. of Geol.*; Huxley, *Contemporary Review*, 1867; Dawson, *Acadian Geol.* 1868; *Month. Mic. Jn.* 1870, p. 319.

COBÆ'A, Cuv.—A climbing Dicotyledonous plant, of the Nat. Order Polemoniaceæ, common in cultivation, remarkable for the curious pyriform cells upon its seeds, containing a spiral fibre (Pl. 21. fig. 20). See Spiral Structures.

COCCID'IUM.—A form of fructification in the Florideæ.

COCCINEL'LA, Linn. (Lady-bird).—A genus of Insects, of the order Coleoptera, and family Coccinellidæ.

C. septempunctata, the common lady-bird. This insect exhibits the circulation through the elytra. If one of these is separated from the body without being detached, and arranged in such manner that it may be viewed as a transparent object, slow and uniform continuous currents, one ascending and the other descending, will be seen between the laminæ of which the elytrum consists. On dividing the latter, an amber transparent liquid containing colourless globules escapes.

Bibl. Nicolet, *Ann. d. Sc. Nat.* 3 sér. 7; Westwood, *Introd. &c.*; Curtis, *Brit. Ent.* 208; Stephens, *Illustr. Brit. Entom.*; Calver, *Käferbuch*, p. 690.

COCCOCAR'PEÆ (Algæ). See Cryptonemiaceæ.

COCCOCAR'PIA, Pers.—A small genus of tropical Lichens, allied to *Pannaria*, but differing chiefly in the monophyllous thallus, whose upper surface is marked by concentric radiations and rugosities.

C. plumbea, Lightf., is British, and has the thallus orbicular, livido-cinerascent, adnate; apothecia reddish-brown; spores 8.

Bibl. Lightfoot, *Fl. Scot.* ii. p. 826, pl. 26; Leighton, *Lich. Flor. G. B.* p. 170.

COCCOCHLO'RIS, Sprengel (*Palmoglœa*, Kütz.).—A genus of Palmellaceæ (Confervoid Algæ), consisting of green microscopic cells, oval or globular, imbedded in a gelatinous matrix, which is at first definite in form (thus differing from *Palmella*), and subsequently effused and shapeless. The green cells are vesicles, filled with granular colouring-matter (chlorophyll) when in active vegetation. They multiply by division; and besides this, some of them grow much larger than the rest, and have their contents converted into a number of cells; these large cells become free from the general frond, and lay the foundation of new ones, originally of definite form, which increase in size by the division of the individuals within a persistent gelatinous investment. Brébisson, Ralfs, and Braun describe a process of conjugation in *C. Brebissonii* (Pl. 3. fig. 6). Two cells come into contact, and their membranes become fused; the intermingled contents then undergo a metamorphosis, brownish oil-globules replacing the chlorophyll; and the 'spore-

cell' thus produced passes through a period of rest before resuming its vegetative development. Thwaites states that the slender filamentous bodies sometimes found in the frond are part of the organization of the plant. We think there must be some error here (see PALMELLACEÆ). Several British species are described:

C. protuberans, Spreng. Frond green, irregularly lobed, spreading on the ground, cells elliptical, about 1-3000″, enlarged vesicles 1-500 to 1-1000″. Hassall, *Br. Fr. Algæ*, pl. 76. fig. 7, pl. 82. figs. 6–10; *Palmella protuberans*, Grev. *Sc. Crypt. Fl.* pl. 243. fig. 1.

C. muscicola, Meneghini. Hassall, *l. c.* p. 78. figs. 3*a*, 3*b*.

C. hyalina, Menegh. Aquatic. Hass. *l. c.* pl. 78. figs. 2*a*, 2*b*.

C. depressa, Menegh. Hass. *l. c.* pl. 78. figs. 4*a*, 4*b*.

C. Mooreana. Hass. *l. c.* pl. 78. 1*a*, 1*b*.

C. rivularis. Hass. *l. c.* pl. 78. 6*ab*.

C. Grevillei, Hass. Frond minute, densely crowded, globose or somewhat lobed, green. In healthy moist situations, frequent. Hass. *l. c.* pl. 78. figs. 7*ab* and 8; *Palmella botryoides*, Grev. *Sc. Crypt. Fl.* pl. 243. fig. 2.

The plants are not yet satisfactorily understood; the relations to *Palmella* and *Glœocapsa* are confused.

BIBL. As above; also Meneghini, *Monogr. Nostochinearum*; Kützing, *Phyc. generalis*; Braun, *Rejuv., Ray Soc.* 1853 (as *Palmoglœa*); Thwaites, *Ann. Nat. Hist.* ser. 2. vol. ii. p. 312 (as *Palmella*); Nägeli, *Einzell. Algen.* 1849; Rabenhorst, *Fl. Alg.* ii. p. 67.

COCCOLITHE or COCCOLITE.—A term applied to the granular varieties of pyroxene (native silicate of magnesia, with metallic silicates).

COCCOLITHS.—The name given by Huxley, in 1858, to minute, oval or round, calcareous bodies (Pl. 18. fig. 56*b*), 1-900″ and less in size, abounding in the Atlantic ooze, either loose or attached to small lumps of protoplasm ('Coccospheres,' Wallich). Two forms were recognized, *Discolithi* and *Cyatholithi*. Similar microliths had been noticed as forming a large proportion of white chalk by Ehrenberg, Reade, and Sorby. Wallich also found them in the North Atlantic, in chalk, in tropical floating Coccospheres, and in dredgings in the English Channel. Haeckel subsequently found them in the harbour of Lanzarote, Carter in the English Channel, and Guembel in limestones of all ages.

Ehrenberg termed these little bodies 'Morpholites of the Chalk,' and regarded them, like his 'Crystalloids,' as due to rearrangement of calcareous particles. Sorby, Huxley, Wallich, and Haeckel differ in opinion as to whether they exist independently or not of Coccospheres and *Bathybius*. Carter ascribes them to an Alga (*Melobesia*).

Coccoliths of either kind, treated with dilute acid, leave a soft flexible cast or film, which is coloured yellow by iodine, pale red with carmine, red by Millon's test, and is dissolved by alkalies.

BIBL. Ehrenberg, *Monatsber. Akad. Berlin*, 1836; *Poggendorff's Annalen*, 1836, xxxix. 101; *Abhandl. Akad. Berlin*, 1838, 67; *N. Jahrb. f. Min.* 1840, 680; *Journ. f. prakt. Chemie*, 1840, xxi. 95; *Edin. N. Phil. Journ.* 1841, xxx. 353; *Mikrogeologie*, 1854; J. B. Reade in *Mantell's Wonders of Geology*, 2nd ed. ii. 953, and 7th ed. ii. 953; Huxley, *Report Deep-sea Soundings, &c.* 1858, 64; *Qu. Mic. Journ.* 1868, 203; Wallich, *Life at Great Depths*, 1860, p. 13; *Ann. N. H.* July 1861, vii. 396, Jan. 1862, viii. 61; Sorby, *Lit. Phil. Soc. Sheffield Proc.* Oct. 1860; *Ann. N. H.* Sept. 1861; Haeckel, *Jenaische Zeitschr.* v. (1870); Guembel, *Jahrbuch Münch.* 1870, 753; Carter, *Ann. N. H.* 1871, p. 184.

COCCONE'IS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, depressed, adnate; valves elliptical, one of them with a median line and central nodule.

The valves are mostly covered with dots (minute depressions), appearing like lines under a low power.

The upper valve differs from the adnate one in not being furnished with the central nodule: under a low power it appears to have a median line, as well as the adnate valve; but this, in some at least, arises from the dots or markings at this part being more closely in contact than elsewhere.

The frustules are often found densely incrusting filamentous Algæ.

C. pediculus (Pl. 12. fig. 17). Frustules very slightly arched (front view); valves elliptical, striæ longitudinal, faint; length 1-1200 to 1-700″; aquatic.

C. placentula. Frustules flat; valves elliptical; striæ longitudinal, faint; length 1-760″; aquatic, common.

C. scutellum (Pl. 12. fig. 18). Frustules

dorsally convex; valves ovato-elliptical, striæ transverse or slightly curved; length 1-700″; marine. β. Nodule dilated into a stauros.

C. Thwaitesii (*Achnanthidium flexellum*, Brébiss., Kütz.). Ends of valves slightly produced; aquatic; length 1-900″.

C. Grevillii. Oval, with transverse canaliculi; marine.

C. diaphana. Elliptical, diaphanous; marine.

Rabenhorst describes 37 European species, with numerous varieties; and enumerates 37 foreign species (with the references).

Bibl. Ehrenb. *Infus.*; Kützing, *Bacill.*, and *Sp. Alg.* p. 50; Smith, *Brit. Diat.* i. p. 21; Rabenhorst, *Flor. Alg.* i. p. 98; Greville, *Micr. Trans.* 1864, p. 9; 1865, p. 33; 1866, p. 126.

COCCONE'MA, Ehr.—A genus of Diatomaceæ.

Char. Frustules stipitate, navicular, somewhat arched (side view); valves with a submedian line, with central and terminal nodules (= stipitate *Cymbellæ*). Aquatic (British).

The valves are transversely striated, the striæ being resolvable into dots (depressions).

7 European species (Rab.).

C. lanceolatum (Pl. 12. figs. 19 & 20). Front view of frustules lanceolate, truncate at the ends; valves semilanceolate, very slightly inflated at the centre of the concave margin; length 1-150″. Common. Stipes dichotomous, jointed.

C. cymbiforme. Scarcely distinct from the last (Sm.); stipites filiform, obsolete, interwoven into a gelatinous mass; length 1-330″.

C. cistula. Front view elliptic-oblong, obtuse; valves inflated on concave margin; stipes elongate, filiform, simple or subramose; length 1-450″; common.

C. parvum (Sm.). Several other foreign species.

Bibl. Ehr. *Infus.*; Smith, *Brit. Diat.* i. p. 75; Kütz. *Bacill.*, and *Sp. Alg.* 59.

COCCOSPHÆRA, Perty.—An obscure genus of Infusoria (Algæ?), consisting of minute spherical granules, with a black, brown, or red nucleus, aggregated into irregular lumps, 1-1400″ in diam.; they exhibit slow motion. In turf-pits &c.

Bibl. Perty, *Kleinst. Lebens.* 1852, p. 104.

COCCOSPHERES.—The name given by Wallich to minute lumps of colourless protoplasm, found in deep-sea ooze, and floating in the tropics. He describes them as spherical or multilobed, from 1-5000 to 1-830″ in size, imitating in shape *Orbulina*, *Nodosaria*, *Textilaria*, *Rotalia*, and *Globigerina*, and coated with numerous oval Coccoliths (Pl. 18. fig. 56 *a*).

From the Atlantic ooze, also, Huxley describes minute granular colourless sarcodic bodies as Coccospheres (1-4500 to 1-1700″), some having Coccoliths on or in them; and he distinguishes (1) the compact, hollow, flattened sphæroids with an envelope, and (2) loose (1-4500 to 1-760″). The corpuscles are free, touching or overlapping (1-11000 to 1-4500″ in size), sometimes mingled with Coccoliths (1-11000 to 1-1600″).

Bibl. Huxley and Wallich. See Coccoliths.

COCCUDI'NA, Duj.—A genus of Infusoria, of the family Plœsconina.

Char. Body oval, depressed or almost discoid, often slightly sinuous at the margin; convex, furrowed or granular and glabrous above; concave beneath, and furnished with vibratile cilia and cirri or corniculate appendages, serving as legs; no mouth.

The species of this genus known to Ehrenberg are arranged among his Oxytrichina and Euplota.

C. costata (Pl. 41. fig. 3). Body obliquely narrowed and sinuous in front, convex and furrowed above, or with from five to six very projecting tubercular ribs; appendages grouped at the two ends; the anterior more slender and vibratile; length 1-950″; in marsh-water.

Three other species. Dujardin remarks that Ehrenberg's genus *Aspidisca* belongs here.

Bibl. Dujardin, *Infus.* p. 445; Claparède and Lachmann, *Infus.* p. 188.

COCKCHAFER. See Melolontha.

COCK-ROACH, or house black-beetle. See Blatta.

COCOA.—This substance consists of the seeds of *Theobroma Cacao* (Ternstrœmiaceæ), and is largely used in a manufactured form under this name; and, mixed with sugar and other ingredients, it forms chocolate. The various powders and pastes thus designated appear to be very extensively falsified. A difference of quality is in the first place produced by the admixture or exclusion of the husk of the seeds; still more important degradation arises from the use of flours of various kinds, ground

roots such as chicory added to give weight, together with coloured earths to disguise these.

The tissues forming the husk of the Cocoa seed include loose filamentous cells, a membrane composed of a single layer of flat parenchymatous cells with thin walls, and another, thicker, consisting of a number of layers of large parenchymatous cells, in the inner part of which are contained spiral vessels and woody fibre; the outer part of the dark-coloured albumen of the seed is composed of angular, the internal mass of rounded cells of delicate structure filled with oil-globules and starch-granules. In the interspaces between the lobes occurs a finely fibrous tissue, in which are found crystals (of fatty matters?). The presence of the filamentous, the large parenchymatous cells, and the spiral vessels indicates when the bark has been ground up with the finer part of the seed.

The various flours and starches are to be detected by the characters of their granules (STARCH); the pitted ducts betray the presence of chicory or other roots (see CHICORY).

Chocolate is a compound made up with starches and sugar, and flavoured with cinnamon, vanilla, and other ingredients. The examination of its preparations must perhaps be limited to comparative richness in cocoa, and to the detection of coarse substitutes for arrowroot and similar starches.

BIBL. Hassall, *Food and its Adult.* p. 207.

COCOA-NUT.—The seed of the Cocoanut Palm, *Cocos nucifera* (Monocotyledon). Sections of the remarkably hard shell of this nut afford good specimens of very greatly consolidated woody tissue, while the fleshy contents form an example of oily albumen, the soft thick-walled cells containing abundance of drops of oil in their cavities. The husk of the nut is composed of fibres analogous in their structure to liber, and used for similar purposes. See FIBROUS STRUCTURES.

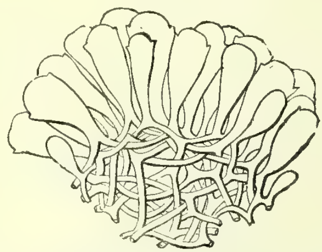
CODI'OLUM, Braun.—A genus of Unicellular Algæ, of which the only known species, *C. gregarium* (Pl. 45. fig. 6), is marine. It consists of a clavate tubular cell, attenuated from about midway into a slender base, by which it is attached to piles, &c. Length, when full-grown, about 1-25″, diameter of the clavate part about 1-300″; green above, clear below. The green contents are finally converted into many 2-ciliated zoospores, which escape by rupture of the cell, as in the sporanges of *Codium*.

C. gregarium was found at Heligoland, and may be looked for on the British coast.

BIBL. Al. Braun, *Alg. Unicell.* Leipsic, 1855, p. 19, pl. 1.

CO'DIUM, Stackh.—A genus of Siphonaceæ (Confervoid Algæ). Marine. The species have dark green spongy fronds of cylindrical, flat, globular or crust-like form, composed of interlacing continuous filaments devoid of septa, terminating in radiating club-shaped filaments at the surface (fig. 133). The sporanges (spores) are

Fig. 133.



Codium tomentosum.
Saccate cells arising from the filaments at the surface. Magnified 10 diameters.

produced in lateral branches from the clavate cells, forming long elliptical sacs, the contents of which are converted into a vast number of biciliated zoospores, discharged when mature (Pl. 5. fig. 15).

BIBL. Harvey, *Br. Mar. Alg.* pl. 24 A; *Phyc. Brit.* pl. 93. 35 B; and Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. 232, pl. 23. figs. 1–5.

CŒLASTRUM, Näg.—A genus of Confervoid Algæ, fam. Pediastreæ (?).

Char. Cell-group or frond globose, hollow internally, formed of a single reticular layer of green cells.

4 species: found in boggy pools.

BIBL. Nägeli, *Einzell. Alg.* p. 97; Rabenhorst, *Flor. Alg.* iii. p. 79.

CŒLENTERA'TA.—Leuck.—A class of the Animal Kingdom, composed of the Acalephæ and Polypi.

CŒLOCYS'TIS, Kütz.—Probably a resting form of EUGLENA.

CŒLOSPHÆ'RIUM, Näg.—A genus of Palmellaceæ (Confervoid Algæ).

Char. Frond globose, minute, hollow within, consisting of minute æruginous cells immersed in a simple mucous envelope.

3 species. In ditches and pools. *Coccochloris*?.

CŒNOCO'LEUS, Berk. and Thwaites.—A genus of Oscillatoriaceæ, distinguished by the filaments growing "within a tough, skinny, more or less permanent outer coat." *C. Smithii* forms a red mat of interlacing threads on boggy soil; the separate filaments are green. *C. cirrhosum*, *Eng. Bot.* p. 2920, is a DESMONEMA.

BIBL. *English Bot.* Supp. pl. 2940.

CŒNOGONIUM, Ehr.—A doubtful genus of tropical Lichens, usually placed among the Lecideinei. The thallus has a cuticular stratum variously and curiously marked.

14 species, growing on leaves, trees, and earth.

BIBL. Leighton, *Ceylon Lich.* p. 172.

CŒNU'RUS, Rudolphi.—A supposed genus of Entozoa, placed in the order Sterelmintha, and family Cystica.

Char. A simple vesicle filled with an albuminous liquid, upon the outer surface of which a number of soft, short, retractile, cylindrical and rugose rather than jointed bodies (scolices) are situated. The head of each resembles that of a *Tænia*, having four disks and a crown of hooks.

The single supposed species, *C. cerebralis* (Pl. 16. fig. 10), is the larva of *Tænia cœnurus*, which infests the dog.

It occurs in the brain of sheep, producing the "staggers;" sometimes also in that of the Horse, the Ox, the Rabbit, &c. The vesicle is as large as the egg of a hen or a pigeon. The scolices when extended are about the 1-5 or 1-6″ in length. When retracted they appear to the naked eye as opaque white specks.

Other kinds occur in the lemur, and the rabbit.

BIBL. Dujardin, *Hist. nat. des Helminthes*, p. 636; Küchenmeister, *Parasiten*, p. 62; Cobbold, *Entozoa*, p. 116, and *Linn. Trans.* 1864.

COFFEE.—The "berries," as they are vulgarly called, of coffee, are the seeds of *Coffæa arabica*, a Dicotyledonous plant, of the Nat. Order Cinchonaceæ.

The "berries" consist of a mass of hard endosperm, composed of closely adherent thick-walled angular cells (horny ALBUMEN), with a thick skin composed of a layer of thin-walled parenchymatous cells forming a membrane, and a layer of hard, easily separable, pitted, thick-walled parenchymatous cells of larger size; true spiral vessels occur in the groove on the inner face of the seed. Ground coffee is subject to very extensive adulterations, most of which may be detected by the microscope,—by which the vascular and parenchymatous tissues of roots, the starch or the integuments of various grains and seeds, &c. (mentioned more particularly under CHICORY) may be discovered.

BIBL. Hassall, *Food and its Adulterations*, pp. 3, 168, 523.

COIR.—The term coir-rope is applied to cordage manufactured from the fibrous tissue of the husk of the cocoa-nut. See FIBROUS STRUCTURES.

COLA'CIUM, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. Not clearly determined. A single eye-spot (sometimes absent); body fixed by a pedicle, which is either single or branched.

Parasitic upon Entomostraca and Rotatoria. A vibratory organ is present in front; but whether consisting of a flagelliform filament or a number of cilia is unknown.

1. *C. vesiculosum* (Pl. 23. fig. 32). Ovato-fusiform, variable, internal vesicles distinct; pedicel very short, rarely branched; bright green; length 1-860″.

2. *C. stentorium*. Cylindrical, conical or funnel-shaped, variable, internal vesicles less distinct, pedicel generally ramose; bright green; length 1-1150″.

BIBL. Ehr. *Infus.* 115.

COLEOCHÆ'TE, De Brébiss.—A genus of Chætophoraceæ (Confervoid Algæ), of which one species, *C. scutata*, is apparently pretty common in freshwater pools, forming minute green disks (fig. 134) adhering to leaves, to the larger Confervæ, sticks, &c., also to the sides of glass vessels in which aquatic plants are kept growing. The disks are formed of a number of dichotomous filaments radiating from a central cell and cohering laterally, the whole being closely applied on the surface of support, so that the discoid form is occasionally modified by this (we have seen it forming a kind of cup and irregular fan-like lobes, on the ends of the articulations of *Hydrodictyon*). In certain cases the filaments are more or less free from their lateral union. The contents of the cells are as usual in this family; Ralfs was in error in stating that they are collected in the centre; this is only the case when about to be converted into zoospores, or when dried. From the back of many of the cells projects a long tubular process (fig. 134), with a bulbous base. The nature

of this structure is very obscure; it is commonly described as open at the summit,

Fig. 134. Fig. 136.

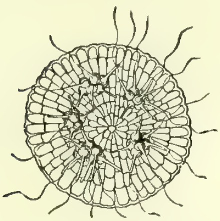


Fig. 135.

Coleochæte scutata.

Fig. 134. A perfect plant. Magnified 25 diameters.
Fig. 135. Propagula from the back of the frond. Magnified 50 diameters.
Fig. 136. Commencement of the development of a frond from a propagulum. Magnified 100 diameters.

from whence is protruded a long bristle. It appears open in dried specimens of *C. pulvinata*; but it is doubtful whether this is not a deception arising from the tube becoming suddenly narrowed into a long bristle-like point. The plants are reproduced by zoospores and by spores. The former are produced singly in the cells, from the whole contents, bear two cilia, and break out at the back of the cell in *C. scutata*, from the side in *C. pulvinata*. The (resting) spores are formed in cells near the margin, in penultimate cells of the radiating filaments, on the back, therefore, in *C. scutata*, at the ends of the branches in *C. pulvinata*. A curious process is described by Al. Braun and Pringsheim as occurring in connexion with this: a terminal cell enlarges very much, and becomes surrounded by a kind of rind or cellular coat, through growth of cellular branchlets from the preceding and the surrounding cells, which branchlets meet and enclose it. This large cell or sporange opens at the end, receives the spermatozoids, and its contents are then converted into 5–8 resting-spores. Pringsheim states that the resting-spores first produce zoospores in germination, one from the whole contents of each spore. The antheridia are simple sacs formed many together, in situations similar to those of the sporanges.

C. scutata, De Bréb. (*Phyllactidium*, Kütz., *Phyc. gen.*) (fig. 134). Fronds discoid, sporanges on the back. On aquatic plants, &c., common (?). A variety, *β soluta* occurs with the radiating filaments more or less free.

C. pulvinata, Braun. Fronds composed of tufted-branched, radiating, free filaments; sporanges globose, at the ends of the filaments. *Chætophora tuberculata*, C. Müll., according to Kützing.

Rabenhorst describes 7 species.

BIBL. De Brébisson, *Ann. des Sc. Nat.* 3 sér. i. p. 29, pl. 2; Ralfs, *Ann. Nat. Hist.* xvi. p. 309, pl. 10; Hass, *Fr. Alg.* 217, pl. 77; Al. Braun, *Rejuv.* (*Ray Soc.* 1853), *passim*; Kützing, *Species Alg.* 424; Müller, *Regensb.* "*Flora*," xxv. B. ii. p. 513, pl. 3 (1842); Pringsheim, *Jahrb.* 1860, ii.; Rabenh. *Flor. Alg.* iii. p. 388.

COLEOP'TERA.—The twelfth order of Insects, containing the beetles. See INSECTS.

COLEOSPO'RIUM, Leveillé.—A genus of Uredinei (Coniomycetous Fungi), separated from *Uredo*, which proves to be a temporary form of many distinct and independent plants (see UREDO). These fungi, which may be well observed in *C. senecionis*, Schlecht., and other common species, appear as yellow, reddish, or brownish pulverulent spots upon the leaves of living plants. Their mycelium, creeping in the intercellular tissues of the plants upon which they are parasitic, consists of delicate branched filaments, which collect together at certain points, become interwoven, at the same time acquiring orange or yellow cell-contents, so as to form a flat cushion-like body (*clinode* or *stroma*). From this arise vertical or radiating, branched, club-shaped, sac-like prolongations of some of the filaments: the oldest are found in the centre, the youngest at the circumference of the group. The club-shaped bodies, filled with yellow or brown contents, become firmly coherent laterally (at this stage they constitute *Uredo tremellosa*). The first spore is formed near the summit of the clavate sac, leaving a little clear space at the tip; then a second spore below the first, and so on to a third and a fourth, occasionally to a fifth; these increase in size so as to conceal the existence of the sacs on which they are seated; only the tips of all the laterally coherent sacs form by their

union a transparent layer, presenting, when seen from above, somewhat the appearance of the corneæ of the compound eye of an insect. This lamella is burst open, with the epidermis of the infected plant; and the spores (now *stylospores*), which grow into oval and globular forms, become detached from one another and lie loose, forming the yellow, red or brown pulverulent spots above alluded to. The spores have a granular cuticle, and their coat is double. The above is the Uredo-form; besides this there is another form of fruit, in which the stalked rows of stylospores are represented by oblong 4–5-locular sacs, each of the chambers of which ultimately emits a long slender tube terminating in a minute reniform 'sporidium' (Tulasne). British species (we cannot find distinctive characters):

1. *C. synantherarum*, Fries. On Colt's-foot, &c., common. *U. compransor*, Schlecht. (in part); *U. tussilaginis*, Pers.

2. *C. senecionis*, Fr. On Groundsel, common. *U. senecionis*, Schlecht.

3. *C. campanulacearum*, Lev. On *Campanulæ*. *U. campanulæ*, Pers.

4. *C. rhinanthacearum*, Lev. On *Euphrasia*, &c. *U. rhinanthacearum*, De C.

5. *C. pulsatillarum*, Fr. *U. pulsatillarum*, Strauss.

6. *C. pinguis*, Lev. On leaves, &c. of roses, common. *U. effusa*, Strauss; Grev. *Sc. Crypt. Fl.* t. 19.

BIBL. Leveillé, *Ann. des Sc. Nat.* 3 sér. viii. 369; De Bary, *Brandpilze*, Berlin, 1853, p. 24, pl. 2; Fries, *Summa Veget.* p. 512; Berk. in *Hook. Br. Fl.* ii. pt. 2. 377–9, &c.; Tulasne, *Ann. des Sc. Nat.* 4 sér. ii. pp. 135, 179.

COLEPI'NA, Ehr.—A family of Infusoria.

Char. Carapace barrel-shaped, traversed longitudinally or transversely, or both, by furrows, in which are situated minute vibratile cilia; truncate, and either smooth or dentate in front; posteriorly terminated by from two to five points or teeth; aquatic.

Ehrenberg states that the oral and anal orifices exist at the opposite ends of the body. The gastric sacculi are readily filled with colouring matter. Motion, that of revolution upon the longitudinal axis.

A single genus: *Coleps*.

CO'LEPS, Ehr.—A genus of Infusoria, of the family Colepina.

Char. Those of the family.

These animals are very voracious, and feed freely upon the portions of the body of crushed Entomostraca, which attract them as much as sugar attracts flies.

C. hirtus (Pl. 23. fig. 33 *a*, Ehr.; fig. 33 *b*, Duj.). Oval, white, rounded behind, carapace tabulate, furrows transverse and longitudinal; posterior teeth three; length 1-570 to 1-430″.

β elongatus. Cylindrical, elongate, length as in the last.

C. viridis. Ovate, furrows transverse and longitudinal, green, posterior teeth three; length 1-960 to 1-570″.

C. amphacanthus. Ovate, carapace divided by transverse furrows only, anterior teeth unequal; posterior teeth three, large; length 1-280″.

C. incurvus. Oblong, nearly cylindrical, slightly curved, white, posterior teeth five; length 1-430″.

C. uncinatus, Berlin; aquatic.

C. fusus, Norway.

BIBL. Ehr. *Infus.* 317; Duj. *Infus.* 365; Clapar. & Lachm. *Inf.* p. 366.

COLLE'MA, Ach.—A genus of gelatinous Lichens. Thallus without cortical layer, but consisting of a gelatinous mass of cells, with granula gonima in moniliform series, and with Lecanorine apothecia. 40–50 species; of which 25 are found on earth, rocks, trees, &c. in Great Britain.

BIBL. Nylander, *Syn.* p. 101, pls. 2, 3, 4; Leighton, *Lich. Fl. G. Br.* p. 16.

COLLEMACEI.—A family of Lichens, having a gelatinous thallus; comprising the tribes LICHENEI and COLLEMEI, which see.

COLLEMEI. — A tribe of gelatinous Lichens, fam. Collemacei, with a membranous lobate thallus.

Gen. *Pyrenopsis, Paulia, Omphalaria, Synalissa, Collema, Leptogium, Hydrothyria, Obryzum, Phylliscum*, and *Pyrenidium*.

COLLENCHY'MA.—A peculiar kind of thickening of cellular tissue in the subepidermal layers of many herbaceous stems, such as *Rumex, Beta, Chenopodium*, &c., which some have regarded as intercellular substance, while others, more correctly, have stated it to consist of metamorphosed secondary layers inside the cells. See for the discussion, INTERCELLULAR SUBSTANCE.

COLLETONE'MA, Brébisson.—A genus of Diatomaceæ.

Char. Frustules navicular, sigmoid or straight, arranged in rows, and immersed in a gelatinous mucus, forming a filiform frond. Aquatic.

C. eximium. Valves sigmoid; length 1-340″.

C. vulgare. Valves elliptic-lanceolate, slightly contracted at ends; length 1-410″.

C. neglectum. Valves elliptic-lanceolate; length 1-250″.

C. subcohærens = *Micromega subcohærens.*

Three other species, *C. viridulum, C. lacustre*, and *C. flexile.*

Rabenhorst arranges these in a section of the genus *Schizonema.*

BIBL. Smith, *Brit. Diat.* ii. 69; Kützing, *Sp. Alg.* 105; Rabenhorst, *Flor. Alg.* i. p. 265.

COLLOID MATTER, EXUDATION and CORPUSCLES (animal).

The term colloid matter or exudation is applied to a transparent, viscid, yellowish, structureless or slightly granular matter, resembling liquid gelatine. It occurs as a normal and a pathological product. In a state of greater consistence, it sometimes forms flakes or irregular masses, which occasionally possess a laminated structure.

In a third form it constitutes spherical, rounded or oval, sometimes flattened microscopic corpuscles—simple masses of sarcode (Pl. 30. fig. 22 *a*). These are either homogeneous, or exhibit numerous laminæ (concentric colloid corpuscles) (Pl. 30. fig. 22 *b*): sometimes a kind of nuclear body is present (fig. 22 *c*); at others they contain carbonate and phosphate of lime (fig. 22 *d*). Sometimes they exhibit a radiate appearance (fig. 22 *e*). In the liquid form, colloid exudation is found within cysts in the thymus and thyroid glands, the ovary, &c., and within the enlarged areolæ of areolar tissue around these organs, &c. It is found in a free state upon the surface of inflamed serous membranes.

The colloid corpuscles are met with in the hypertrophied heart, in the prostate, the thyroid, and the thymus glands, in the choroid membrane, in the brain and spinal cord, and in the (waxy) spleen, &c.

The liquid colloid matter is not precipitated by acetic acid; it becomes of a gelatinous consistence, retaining its transparency or turbid and opaque, by heat. The colloid corpuscles do not, however, appear to be uniform in composition; sometimes they consist of a proteine-compound; at others, probably, of cellulose or amyloid, as in the brain (true CORPORA AMYLACEA). These bodies are further noticed under the heads of the tissues and organs in which they occur. See also TUMOURS (*Colloid cancer*).

BIBL. Rokitansky, *Path. Anat.* i. p. 304; Wedl, *Grundzüge d. Path. Histol.*; Förster, *Hand. d. Spec. Path.*; Virchow, *Arch. f. Path. Anat.* v.; Rindfleisch, *Path. Gewebelehre*; Green, *Pathol. &c.* p. 57.

COLLO'MIA, Nutt.—A genus of Polemoniaceæ (Dicotyledons) remarkable for the spiral structures produced in the epidermis of the seeds (Pl. 21. fig. 22) (see SPIRAL STRUCTURES). The gummy substance in which fibre is imbedded is soluble in water and not in spirit; therefore the best way to observe the elastic opening of the spiral fibres is to make fine sections of the coat of the seed and place them in a little spirit of wine, upon a slide, with a covering glass: to adjust the focus, and then to add water carefully at the side of the covering glass so as to wash away or dilute the spirit.

COLLOSPHÆRA, Müll.—A genus of Radiolaria, fam. Thalassicollidæ.

Char. Skeleton consisting of simple spherical roundish or polyhedral fenestrated shells, smooth or spinous, each of which surrounds one of the combined central capsules.

C. Huxleyi (*Thalassicolla punctata*, pt.). Shell smooth; diam. $\frac{1}{250}$″. In various seas.

C. spinosa. Shell spinous. Messina.

BIBL. Haeckel, *Radiolar.* p. 533; Huxley, *Ann. N. Hist.* 1851, viii. p. 434, pl. 16. fig. 6.

COLOSTRUM.—The first liquid secreted by the mammary glands. See MILK.

COLOUR. See INTRODUCTION, p. xxx.

COLOURING MATTER, OF ANIMALS. See PIGMENT.

COLOURING MATTERS, of PLANTS. The green colour of vegetables depends upon the presence of CHLOROPHYLL, and is spoken of under that head. The red and yellow colours assumed by leaves and herbaceous shoots in autumn depend upon a chemical metamorphosis of the chlorophyll, or on its absorption and the discoloration of the cellular tissue. The colours of red cabbage, copper beech and similar plants, depend upon the existence of a colouring liquid in the usually colourless epidermal cells, obscuring the chlorophyll which lies beneath. The red colour presented by many of the lower Algæ, such as some of the Palmellaceæ, appears also to depend upon a metamorphosis of the chlorophyll, connected with the vital processes; it is met with also in the contents of the resting-spores of many of the filamentous Confer-

voids. We have found the protoplasm assuming a reddish colour in the *punctum vegetationis* of the buds of Monocotyledons in the autumn, which probably depends upon a similar cause. The bright colours of flowers and other parts of the inflorescence of plants, as also of the lower surface of many leaves (*Begoniæ, Victoriæ*, &c.) and herbaceous shoots, arise from the presence of matters of a different kind, almost always dissolved in the watery cell-sap. The colour of petals is ordinarily found to depend upon a certain number of the cells subjacent to the epidermal layer being filled with a coloured fluid; and the depth of the colour is proportionate to the number of superimposed layers of such cells, which act like so many layers of a pigment. Each cell is usually filled with one colour when fully developed; but adjacent cells are often seen, in variegated petals, to contain distinct colours, the line of demarcation being accurately fixed by the cell-walls, through which the colours do not transude, unless the cells are injured by pressure. In young tissues the colour often has a granular appearance in the cells; but this is a deception arising from the mode in which the colour is developed. The colourless protoplasm originally filling the cells becomes excavated, as it were, by water-bubbles, and the watery contents of the excavations become coloured; they gradually enlarge as the protoplasm applies itself more completely to the walls of the cell, until they become confluent and the coloured liquid fills the whole cell-cavity. The isolation of the coloured juice in each particular cell seems to depend upon the primordial utricle or parietal layer of protoplasm; when this is injured by pressure, or other external cause, endosmose is soon set up and the intregrity of the cell destroyed.

In some cases the liquid colouring matters of flowers have been found to contain solid corpuscles: the red colour-cells of *Salvia splendens*, and the blue ones of *Strelitzia regina*, contain globules; and according to von Mohl, this is still more commonly the case with the yellow colours: in the yellow perigonal leaves of *Strelitzia regina* the yellow colour is said to depend upon the presence of crescentic and curled filaments floating in the cell-sap.

The white patches upon variegated and spotted leaves, such as those of *Aucuba*, Holly, variegated Mint, *Begonia argyrostigma*, &c., arise from the absence of chlorophyll in the cells subjacent to the epidermis at those parts, which produces the same effect as we see in leaves mined by caterpillars.

Bibl. Von Mohl, *Verm. Schrift.* 575.

COLPO'DA, Schrank, Ehr.—A genus of Infusoria, of the family Colpodea, Ehr., Colpodina, Cl. & L.

Char. No eye-spot, tongue-like process present, ventral surface ciliated, dorsal not; strongly recurved in front.

Dujardin says: Body sinuous or notched on one side, sometimes reniform, surface reticulated or marked with nodular obliquely interlacing striæ; mouth lateral, situated at the bottom of the notch, and furnished with a projecting lip.

C. cucullus (Pl. 24. fig. 25). Turgid, slightly compressed, reniform, often narrowed in front; length 1-1720 to 1-280″. Common in vegetable infusions of hay. Ecdysis has been observed in this animalcule.

Stein describes the encysting process and reproduction from spores as occurring in this infusorium. There can be little question, however, that his observations apply to *Paramecium chrysalis*, E. (*Pleuronema chr.*, Duj.); Cl. & L. *Inf.* p. 270.

C.? ren. Ovato-cylindrical, reniform, rounded at the ends; aquatic; length 1-280″.

C.? cucullio (*Loxodes cuc.*, Duj.). Compressed, flat, elliptical, slightly sinuous in front; aquatic; length 1-900″.

C. parvifrons, Cl. & L. No anterior recurvature, contractile, vesicle not terminal. Aquatic.

Bibl. Ehr. *Infus.* 347; Duj. *Infus.* 478; Stein, *Infusionsth.* 15.

COLPO'DEA, Ehr.—A family of Infusoria.

Char. Gastric sacculi present; no carapace; oral and anal orifices distinct, neither at the ends of the body.

Body usually covered with longitudinal rows of cilia. The sacculi can be filled with colouring matter.

Genera:

No eye-spot.
  A tongue-like process.
    No cilia on the dorsal surface... *Colpoda.*
    Cilia on every part.................. *Paramecium.*
  No tongue-like process.
    Body narrowed and prolonged in front (proboscis, E.), tail present .... *Amphileptus.*
    Proboscis absent, tail present... *Uroleptus.*
An eye-spot................................ *Ophryoglena.*

Bibl. Ehrenb. *Infus.* 345.

COLPODI'NA, Cl. & L.—A family of Infusoria, characterized by the presence of cilia all over the body, the patent and ciliated œsophagus, and the absence of rows of buccal cilia directing the particles of food to the mouth.

Genera:

Membranous lips absent.		
No setæ projecting from the mouth	1.	*Paramecium.*
Setæ projecting from the mouth.		
A bundle of short setæ forming a lower lip	2.	*Colpoda.*
Oral setæ long, isolated.		
No ventral setæ	3.	*Cyclidium.*
A bundle of ventral setæ	4.	*Pleuronema.*
Lips membranous, oscillatory	5.	*Glaucoma.*

COLUREL'LA, Bory, Duj. = *Colurus* Ehr.

COLU'RUS, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Two frontal eye-spots; tail-like foot forked; carapace cylindrical or compressed.

Carapace open beneath; cervical appendage curved; jaws with two or three teeth each.

1. *C. deflexus* (Pl. 34. fig. 12, dorsal view; 13, ventral view; 14, teeth). Carapace ovate; compressed, its posterior points long and directed downwards; terminal points of foot (toes, E.) shorter than the foot itself; length of carapace 1-240''. Aquatic.

2. *C. caudatus.* Carapace ovate, compressed, posterior points of carapace distinct, points of foot longer than the foot itself; aquatic and marine; length 1-240''.

C.? uncinatus and *bicuspidatus* are doubtful species.

BIBL. Ehr. *Infus.* 475.

COMBEA, D.N.—A genus of podetiiform Lichens, tribe Roccellei. 1 species, *C. mollusca*; rocks, Cape of Good Hope.

BIBL. Ach. *Meth.* p. 235, pl. 4. f. 5; Nyl. *Syn.* p. 257, pl. 8. f. 1.

COMPRESSOR. INTRODUCTION, p. xxi; Ross's new compressor is described in *Qu. Micr. Journ.* 1864, p. 44.

COMPSOGON, Mont.—A genus of Lemaneeæ (Confervoid Algæ).

1 European species: *C. Corinaldii.* Capillary much branched, violet. Aquatic.

CONCEPTACLE.—A form of fructification in the FLORIDEÆ and FUCOIDEÆ. Also occurring in the fructification of some Fungi.

CONCHŒCIA, Dana.—A genus of Ostracode Entomostraca, fam. Conchœciadæ.

Char. Those of the family.

C. obtusata, Sars. Shetland.

BIBL. Dana, *Crustac. Explor. Expedit.* &c.; Sars, *Oversigt af Norges mar. Ostr.* p. 118; Brady, *Linn. Trans.* xxvi. p. 469.

CONCHŒCIADÆ.—A family of Entomostraca, of the order Ostracoda.

Char. Inferior antennæ 2-branched, one branch rudimentary and immoveable; feet 2 pairs, posterior rudimentary, eyes none. 1 genus, *Conchœcia.*

CONCRETIONS and CALCULI.—These terms are rather indefinite. A hard body of considerable comparative size, formed within an animal organism, would be called a calculus, whilst a body of considerable comparative size in which hardness was not a marked feature, or a hard body of small or microscopic dimensions, would be called a concretion. Under the latter term, the notion of a compound structure is usually implied. Calculi generally consist of various organic and inorganic substances entering into the composition of the secretions of the body, which are precipitated from various causes. Those found in the intestinal canal are mostly composed of undigested vegetable tissues derived from the food. Most, if not all, calculi and concretions are mixed with animal matter (proteine-compounds) derived from the mucous cavities in which they are contained,—or simultaneously precipitated, with their characteristic components, from the secretions in the midst of which they are formed. Hence when the proper calculous matter is dissolved by a reagent which exerts little or no action upon the animal matter, a mass is left which exhibits the form of the original body; and the organic cast often so resembles a cell, that some hasty observers have attributed to calculi a cell-origin.

Calculi and concretions enlarge by the deposition of new matter upon their outer surface; and as this deposition is not uniform and uninterrupted, either in regard to the nature or proportion of the respective constituents, they mostly exhibit a laminated structure. This is visible to the naked eye in the larger ones, and evidenced in those which are microscopic by the appearance of concentric rings, and of a nucleus or nuclei. These concentric rings and nuclei are distinguishable equally in concretions formed artificially and in those occurring naturally.

The inorganic matter in concretions is in the crystalline state, the crystals being

usually small, radiate, and intermingled with the organic substance; which arrangement is conveniently expressed by Ehrenberg's term "crystalloid." The crystalloids have a great resemblance to cells, for which they have often been mistaken.

BIBL. Taylor, *Hunterian Catalogue*, Calculi; Quekett, *Med. Times*, 1851, xxiv. p. 551; Griffith, *Med. Times and Gaz.* 1852, xxv. p. 272; Rainey, *Medico-Chir. Rev.* 1857, and *Qu. Micro. Journ.* 1858; Meckel, *Mikrogeologie*.

CONDENSER, BULL'S-EYE, &c., for opaque objects. INTRODUCTION, p. xviii.

CONFER'VA, Plin.—A genus of Confervaceæ (Confervoid Algæ), which, as restricted here, contains chiefly marine species; but we have thought it advisable to retain in it the species separated by Kützing as *Chætomorpha* and by Thuret as *Microspora*; so that our *Conferva* corresponds to Hassall's proposed genus *Aplonema*. The plants consist of unbranched filaments, composed of cylindrical or moniliform cells the length and diameter of which have a very variable relation in different species, and containing starch-granules. The species with moniliform cells form Kützing's *Glœotila*. They are reproduced by zoospores formed from the cell-contents. Braun says that *C. bombycina* produces four in a cell. According to Thuret, *C. ærea* produces large numbers, which escape by a lateral orifice, while the species he describes as *Microspora floccosa* forms a number which escape by a circular dehiscence breaking up the filaments. The zoospores are 2-ciliated in general, but sometimes bear four. The spores have not been observed; and hence Kützing has suggested that the *Confervæ* may be sterile forms of *Œdogonium*; but the true *Œdogonia* produce solitary zoospores with a crown of cilia. Rabenhorst describes 30 species. British species:—

Freshwater.

1. *C. bombycina*, Ag. Filaments 1-360 to 1-180″ in diameter, four or five times as long, forming a yellow-green cloudy stratum. Common in stagnant water. Dillw. *Confervæ*, pl. 60.

2. *C. floccosa*, Ag. (Pl. 5. fig. 11 *b*). More robust; articulations once or twice as long as broad. *Microspora floccosa*, Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. pl. 17. figs. 6, 7.

Marine.

Thirteen species are described by Harvey (*Brit. Marine Algæ*), of which *C. ærea*, Dillw. is one of the commonest, remarkable for the large size of the tufted filaments, as thick as hog's-bristles, growing 3 to 12″ long, of a yellow-green colour. *C. Melagonium*, Web. and Mohr, has erect tufted filaments equally thick, while *C. Linum*, Roth, has entangled filaments twice as thick, deep glossy green, and many feet long.

The cell-walls of these large marine species present a curious striated appearance when treated with acids, which has led J. Agardh, apparently erroneously, to suppose they are composed of spiral filaments. (See SPIRAL STRUCTURES.)

BIBL. Harvey, *loc. cit.*, *Phyc. Brit.*; Thuret, *loc. cit.*; Kützing, *Spec. Alg.*; Hassall, *Brit. Freshw. Alg.* 213; Braun, *Rejuv.* (*Ray Soc.* 1853, p. 184); Rabenhorst, *Fl. Alg.* iii. p. 322.

CONFERVA'CEÆ.—A family of Confervoideæ. Marine or freshwater Algæ; composed of articulated filaments, simple or branched; cells cylindrical, shortish, not conjugating. The fourth and fifth genera given below are placed here doubtfully; *Stigeoclonium*, if a good genus, leads to *Draparnaldia* among the Chætophoraceæ. Reproduction by zoospores; spores unknown.

Synopsis of the British Genera.

1. *Cladophora.* Filaments tufted, much branched. Sea and fresh water. Zoospores minute, many in a cell.

2. *Rhizoclonium.* Filaments decumbent, with small root-like branches. Zoospores minute, numerous. Sea, brackish, and fresh water.

3. *Conferva.* Filaments unbranched. Zoospores minute, numerous in the cells. Sea, brackish, and fresh water.

4. (?) *Ulothrix.* Filaments simple, often fasciculated, joints short. Zoospores four-ciliated, two, four or more in a cell. Fresh water.

5. (?) *Stigeoclonium.* Filaments branched tufted, the ramules running out into slender points; cell-walls often dissolving to emit the zoospores. Zoospores four-ciliated, one in a cell.

BIBL. See the genera.

CONFERVOI'DEÆ or CHLOROSPO'REÆ.—An order of Algæ. The Chlorospores or Confervoids, the lowest order of the Algæ, display a preponderating number of truly microscopical plants, and constitute one of the favourite and most instructive

fields of microscopic research. As yet, however, the minute history of development is wanting in a very large number, while the facts already disclosed are so varied, that it becomes a matter of difficulty to draw up a sketch of their characteristics in a brief space.

Among the Palmellaceæ we find some of the simplest forms of vegetable life, where the organization is reduced to the condition of a single microscopic membranous vesicle, enclosing nitrogenous contents, ordinarily tinged with chlorophyll, and containing starch. Such we have in *Protococcus,* which in its various forms appears as a green or red stain on damp surfaces, or a green or red scum in water. These plants multiply by the subdivision of the cells into two or four new ones, which separate and repeat the process. In addition to the vegetative growth by subdivision going on in damp air (the cells being held together more or less firmly into a gelatinous crust), the contents of the individual cells are set free by solution of the membranes when placed in water, and emerge as ciliated zoospores, endowed with active motion. Advancing a step, we come to a number of genera not yet well defined, in which the membranes of the parent cells soften into a kind of gelatine, during the process of subdivision, and hold the new cells together in groups of definite or indefinite form; among these are *Palmella, Glœocapsa,* and others of like nature, in which at present no zoospores have been discovered. In *Coccochloris* a process of conjugation occurs. These genera exhibit a *resting* form, characterized by the increased thickness of the membrane of the cell, and a change of the green contents into a brownish, reddish, or even crimson colour.

With the Palmellaceæ we shall associate a number of Unicellular Algæ, whose characters and affinities are still obscure.

The Ulvaceæ are not widely separated from the Palmellaceæ; but the conjunction of the cells into a definite membrane indicates a higher organization. In other respects, however, they hardly differ more from some of the more perfect genera of Palmellaceæ than those do from *Protococcus*; and therefore, although more conspicuous and extensively developed than the Nostochaceæ and Desmidiaceæ, it seems natural to place the Ulvaceæ near the Palmellaceæ, especially as the reproduction by cell-division and by zoospores is analogous in all respects to what is seen in *Protococcus,* of which they would appear to be the *permanently aquatic* representatives. *Prasiola* and *Schizogonium,* however, differ from the other Ulvaceæ in the absence of zoospores, the contents (homogeneous, not granular) of the cells being discharged as motionless spore-like bodies, from which new fronds grow up. Some authors separate these genera; but we are hardly in a position to determine the exact place of these plants at present.

The Nostochaceæ exhibit but a slight advance in organization over the Palmellaceæ. They are composed of linear series of cells, mostly inflated so as to give the filaments a beaded appearance; the linear series increase in length by transverse division, and also in some stages subdivide longitudinally; larger globular cells (sporanges) occur at intervals in the lines, with others devoid of endochrome (vesicular cells, Thwaites). During the increase, the older external membranes soften into a gelatinous coat. In *Nostoc,* where the filaments accumulate in large quantity, they lie elegantly curled and entwined in masses of this jelly, which exhibit a more or less definite, lobed, external form, appearing to the naked eye as gelatinous crusts or globular masses, as they lie upon damp ground or among mosses. Each sporange produces one resting-spore, which breaks out from it in germination.

Nearly allied to *Protococcus* stands a family which until recently have been regarded by most authors as animals, namely the Volvocineæ, which consist essentially of groups of organisms identical with the ciliated zoospores, held together in a definite form by a common membranous envelope, through which the cilia penetrate, so that the entire full-grown plant moves freely in the water, as in *Volvox, Gonium, Pandorina,* &c. These plants multiply by division and also by resting-spores, which are formed after a true fecundation by spermatozoids.

The Desmidiaceæ form another tribe of very simple organization, where the individual plant is composed of a single cell; but here the coat or enclosing membrane is peculiarly characterized by the assumption of remarkable forms unlike any other vegetable structures, presenting angular and escalloped outlines or elegant processes projecting from the wall, but always so as to exhibit a bilateral symmetry. These cells are isolated, or arranged in linear series or beautiful complicated star-like groups, enclosed at

first in a common gelatinous envelope, but readily breaking up into isolated frustules. They are further remarkable for exhibiting the process of *conjugation* with great distinctness, resulting in the production of peculiarly formed bodies with rigid external membranes, which are generally regarded, probably correctly, as sporanges. They are also reproduced by zoospores.

The Diatomaceæ are nearly related in many respects to the Desmidiaceæ, but, on the other hand, diverge from the ordinary characters of plants so much in other respects, that some authors have placed them in the animal kingdom. Like the Desmidiaceæ, they are microscopic simple cells, isolated or coherent in groups, and either free or imbedded in a definitely or indefinitely formed mucous nidus. They differ, however, from the Desmidiaceæ in possessing when free a more active power of locomotion, and also by being often attached by a kind of foot, and this either singly or in large polypiform families. Their great distinctive character is the presence of a siliceous coat to the cell, which preserves the form of the organism when the soft parts are removed by fire or acids. The cell-contents of the Diatomaceæ are usually of a dirty yellow colour, and this appears to depend upon a modification of chlorophyll. The reproduction is by division and by conjugation, analogous to that of the Desmidiaceæ.

The Oscillatoriaceæ are truly filamentous plants, the component parts of which, though readily separating under external influences, are often combined into complex fronds in their normal state. The filaments of this group are mostly very minute, and exhibit transverse markings, which in some cases are so delicate that they cannot be regarded as actual divisions of cell-contents by septa; yet the filaments break readily across in these places, and the fragments go on growing. In the larger forms the articulations of the cell-contents are more distinct; but even here the filaments look like rows of individual masses of cell-contents contained in a common tube, forming a kind of sheath. In some genera the filaments are contained in bundles in secondary sheaths. The most remarkable point about this tribe is the occurrence of the peculiar kind of motion in the typical genus *Oscillatoria*, whence it derives its name: the filaments emerge readily from their sheaths and wave backwards and forwards, and the broken fragments oscillate like the beam of a balance; from what cause, or by what means, is still unknown.

The only known mode of reproduction is by the breaking-up of the filaments into longer or shorter pieces, or into single joints. Peculiar large cells occur at the base of the filaments of some of the adnate genera; but their nature is unexplained.

The Siphonaceæ are plants of larger dimensions and higher organization than any of the preceding; and indeed they are placed among the lower Fucoids by some authors. They seem to us to be more in place here. They are composed of tubular cells of much larger size than those of any other Confervoids, the entire plant often consisting of one undivided tube, while in other cases the branches arise from true articulations. In *Botrydium* a very curious structure is exhibited: the plant consists of a tough membranous globule, filled with green matter, rising from a branched, colourless, root-like portion spreading in the damp ground, the whole consisting only of one very large undivided cell. In *Vaucheria* and *Bryopsis* the tubular cell grows into a long filament, more or less branched, but not divided. In *Hydrodictyon*, which from its general structure appears referable here, the plant is a large net with meshes half an inch broad, the net itself being composed of large tubes rounded at both ends, articulated at the intersections of the meshes. In *Codium*, the filaments are closely combined into a spongy mass. The fructification of these genera is very varied, so that the group appears scarcely natural; but the plants are all more or less anomalous, and have affinities with very different tribes, while the comparatively enormous cells of which they are composed are peculiar to them among the filamentous Confervoids. *Vaucheria* is reproduced by very large oval gonidia covered with innumerable vibratile cilia, by means of which they swim actively in water; the gonidia are developed from the contents of the ends of the filaments; and zoospores, produced under various circumstances, seem to occur in all the other genera. In *Vaucheria* sexual reproduction is also known, sporangial and antheridial branches being formed at the sides of the main filaments. We have for convenience included the *Saprolegnieæ* (*Achlya*, &c.) in this family on account of their general structure; but they are distinguished by the absence of chlorophyl in their cell-

contents, and their parasitic habit, which gives them the character of aquatic Fungi.

The Œdogoniaceæ are green, simple or branched, filamentous plants, attached to foreign bodies under water—their cells, filled with green matter, presenting a peculiar mode of division; and the entire contents of the cells are converted into zoospores which have a crown of numerous cilia. In the sexual reproduction, the spores are formed from the entire contents of certain cells, which are impregnated by spermatozoids produced on other parts of the plant, or by antheridial plants developed from some of the gonidia.

The Zygnemaceæ are somewhat similar filamentous plants, remarkable for the process of CONJUGATION or inosculation of neighbouring cells of distinct filaments, in order to the production of the resting-spores. They are also distinguished by the endochrome being arranged in spiral bands or other patterns on the cell-walls. It is doubtful whether zoospores occur here normally.

The Confervaceæ are simple or branched filamentous forms, of which the essential characters are imperfectly known. They produce numerous zoospores with two or four cilia in each cell. Sexual reproduction is unknown here.

The Chætophoraceæ differ from the Confervaceæ principally in their habit and mode of branching. They occur in fresh water and in the sea, and are characterized by the presence of a jelly enveloping the filaments, which form branched, round, or shapeless masses, or flat discoid or irregular plates, and by the cells constituting the joints of the filaments bearing slender bristle-like branches. They are reproduced by zoospores, either numerous or solitary in the cells, bearing *four* cilia; also by spores formed after fecundation.

The Batrachospermeæ exhibit a greater complexity of structure, consisting of jointed moniliform filaments, composed of rows of cells, branched and bearing whorls of ramuli; the filaments of the whorls dense, dichotomous, and beaded, some of them growing down over the central filament, and forming a sheath round it. The fructification consists of spore-like bodies borne on the filaments of the whorls, and of bodies resembling the antheridia of the Florideæ. The plants are brownish green or purplish, and occur in fresh water.

The Lemaneeæ are freshwater Algæ, by some supposed to bear a close relation to the lower Fucoids, occurring in rapid rivers, attached to stones. The fronds are branched and of leathery texture, consisting of tubes composed of cellular tissue,—the superficial layers small, polygonal, and firmly conjoined—the deeper layers, bounding the cavity of the tubes, lax and spherical. The fructification consists of beaded filaments arising from the internal cells, and growing out freely in the cavity of the tube, finally breaking up into the component bead-like cells (*spores*), which reproduce the plant. The genus *Lemanea* deserves further investigation.

Synopsis of the Families.

1. LEMANEEÆ. *Frond* filamentous, inarticulate, cartilaginous-leathery, hollow, furnished at irregular distances with whorls of warts, or necklace-shaped. *Fructification*: tufted, simple or branched, necklace-shaped filaments, attached to the inner surface of the tubular frond, and finally breaking up into elliptical *spores*. *Growing in fresh water.*

2. BATRACHOSPERMEÆ. *Plants* filamentous, articulated, invested with gelatine. *Frond* composed of aggregated, articulate, longitudinal cells, whorled at intervals with short, horizontal, cylindrical or beaded, jointed ramuli. *Fructification*: ovate *spores* and tufts of *antheridial cells* (?) attached to the lateral ramuli, which consist of minute, radiating, dichotomous, beaded filaments. *Freshwater plants.*

3. CHÆTOPHORACEÆ. Plants growing in the sea or fresh water, coated by gelatinous substance: either filiform, or (a number of filaments being connected together) constituting gelatinous, definitely formed or shapeless fronds or masses. *Filaments* jointed, bearing bristle-like processes. *Fructification*: *zoospores* produced from the cell-contents of the filaments; *resting-spores* formed from the contents of particular cells after impregnation by ciliated spermatozoids produced in distinct *antheridial cells* (*Coleochæte*).

4. CONFERVACEÆ. Plants growing in the sea or in fresh water, filamentous, jointed, without evident gelatine (forming merely a delicate coat around the separate filaments). *Filaments* very variable in appearance, simple or branched; the cells constituting the articulations of the filaments more or less filled with green or very rarely brown or purple granular matter,

sometimes arranged in peculiar patterns on the walls, and convertible into *spores* or *zoospores*. Not conjugating.

5. Zygnemaceæ. Freshwater filamentous plants, without evident gelatine, composed of series of cylindrical cells, straight or curved. Cell-contents often arranged in elegant patterns on the walls. *Reproduction* resulting from *conjugation*, followed by the development of a true *spore*, in some genera dividing into four *sporules* before germination.

6. Œdogoniaceæ. Simple or branched, freshwater, filamentous plants, attached, without gelatine. Cell-contents uniform, dense. Cell-division accompanied by circumscissile dehiscence of the parent cell, producing rings upon the filaments. *Reproduction*: by *zoospores* formed of the whole contents of a cell, with a crown of numerous cilia: *resting-spores* formed in sporangial cells after fecundation by ciliated spermatozoids formed in *antheridial cells*.

7. Siphonaceæ. Plants found in the sea, fresh water, or on damp ground; of a membranous or horny hyaline substance, filled with green (or in *Saprolegnieæ* colourless) granular matter. *Fronds* consisting of continuous tubular filaments, either free or collected into spongy masses of various shapes, either crustaceous, globular, cylindrical, or flat. *Fructification*: by *zoospores* either single or very numerous; and by *resting-spores* formed in sporangial cells after the contents have been impregnated by the contents of *antheridial cells* of different form.

8. Oscillatoriaceæ. Plants growing either in the sea, in fresh water, or on damp ground, of a gelatinous substance and filamentous structure. *Filaments* very slender, tubular, continuous, filled with coloured, granular, transversely striate substance; seldom branched, though often cohering together so as to appear branched, usually massed together in broad floating or sessile strata, of very gelatinous nature; occasionally erect and tufted, and still more rarely collected into radiating series bound together by firm gelatine, and then forming globose, lobed, or flat crustaceous fronds. *Fructification*: the internal mass, or "contents," separating into roundish or lenticular gonidia.

9. Nostochaceæ. Gelatinous plants growing in fresh water or in damp situations among mosses, &c.; of soft or almost leathery substance, consisting of variously curled or twisted necklace-shaped filaments, colourless or green, composed of simple (or in some stages double) rows of cells, contained in a gelatinous matrix of definite form, or heaped together without order in a gelatinous mass. Some of the cells enlarged, and then forming either *vesicular* empty cells or densely filled *sporangial* cells. *Reproduction*: by the breaking up of the filaments, and by *resting-spores* formed singly in the sporanges.

10. Ulvaceæ. Marine or freshwater Algæ, consisting of membranous flat and expanded tubular or saccate fronds composed of polygonal cells firmly conjoined by their sides. *Reproduced* by *zoospores* formed from the cell-contents and breaking out from the surface, or by motionless *spores* formed from the whole contents of a cell.

11. Palmellaceæ. Plants forming gelatinous or pulverulent crusts on damp surfaces of stone, wood, &c., or more or less regular masses of gelatinous substance, or delicate pseudo-membranous expansions or fronds, of flat, globular, or tubular form, in fresh water or on damp ground; composed of one or many, sometimes innumerable, cells with green, red, or yellowish contents, spherical or elliptical form,—the simplest being isolated cells (found in groups of two, four, eight, &c. in course of multiplication); others permanently formed of some multiple of four; the highest of compact, numerous, more or less closely conjoined cells. *Reproduction*: by cell-*division*, by the conversion of the cell-contents into *zoospores*; and by *resting-spores*, formed sometimes after conjugation, in other cases probably after fecundation by spermatozoids.

We shall include under the head of Palmellaceæ all those obscure Unicellular Algæ whose place is not at present satisfactorily known.

12. Desmidiaceæ. Microscopic, gelatinous plants, of a green colour, growing in fresh water, composed of cells devoid of a siliceous coat, of peculiar forms, such as oval, crescentic, shortly cylindrical, or cylindric-oblong, &c., with variously-formed rays or lobes, giving a more or less stellate form, presenting a bilateral symmetry, the junction of the halves being marked by a division of the green contents; the individual cells either free, or arranged in linear series, collected into faggot-like bundles, or in elegant star-like groups, which are imbedded in a common gelatinous coat. Reproduced by *division* and by *resting-spores* produced in

sporangia formed after the conjugation of two cells and union of their contents, and by *zoospores* formed in the vegetative cells (*Pediastrum*), or in the germinating resting-spores.

13. DIATOMACEÆ. Microscopic cellular bodies, growing in fresh, brackish, and sea water; free or attached, single or imbedded in gelatinous tubes, the individual cells (*frustules*) with yellowish or brownish contents, and provided with a siliceous coat composed of two usually symmetrical valves variously marked, with a connecting band or *hoop* at the suture. Multiplied by *division* and by the formation of *new larger individuals* out of the contents of *conjugated cells*; perhaps also by *spores* and *zoospores*.

14. VOLVOCINEÆ. Microscopic, cellular, freshwater plants, composed of groups of bodies resembling zoospores, connected into a definite form by their enveloping membranes. The plants (families) are formed either of assemblages of coated zoospores united in a definite form by the cohesion of their membranes, or of assemblages of naked zoospores enclosed in a large common investing membrane. The individual zoospore-like bodies with two cilia throughout life, perforating the membranous coats, and by their conjoined action causing a free movement of the entire group. *Reproduction*: by division (*Gonium*) or by single cells becoming converted into new families (*Pandorina*, *Volvox*); and by *resting-spores* formed from some of the cells after impregnation by spermatozoids formed from the contents of other cells of the same family.

BIBL. See the Families.

CONID'IA.—The name applied by Fries to the stalked spores or reproductive cells produced directly from the mycelium of many Fungi: characteristic of the Coniomycetes. Late discoveries have rendered the term of somewhat equivocal value; and it is not yet sufficiently distinguished from the organs called STYLOSPORES and SPERMATIA. Physiologically, they are regarded as equivalent to the gonidia of Lichens.

CONIF'ERÆ.—A class of Gymnospermous plants, so called from the peculiar form of the female inflorescence, in which the flowers are collected into imbricated cones; this is the case at least in the Abietineæ and Cupressineæ: in the Taxineæ, which are separated by some authors, the female flowers are solitary. These plants are remarkable in many respects. The processes occurring in the fertilization of the ovules are quite different from those in the Angiospermous flowering plants, and form a link with the conditions in the higher Flowerless plants. (See GYMNOSPERMIA.) The pollen is of a remarkable form in the Abietineæ. The most striking point, however, in relation to the microscopic structure, is the condition of the stems of these plants. The wood is entirely composed of prosenchymatous cells, of large size, without intermixture of ducts or vessels; and those walls of the cells parallel with the medullary rays (very rarely those at right angles) are marked with one or more rows of the peculiar bordered pits which have been wrongly called glands (Pl. 1. fig. 4). The structure of these is explained under the head of PITTED STRUCTURES. It must be understood, however, that the peculiarity of Coniferous wood does not depend on the presence of these, which are common, but on the simultaneous absence of *ducts*. The wood of the Yew presents in addition a spiral fibre, between the coils of which the pits lie. (See TAXUS.) These peculiar conditions of the wood render it possible to identify it in microscopic sections in a recent, and, if tolerably well preserved, even in a fossil state; the Coniferous structure may be readily detected in silicified wood, in which almost all trace of organic matter is lost, the silica forming complete *casts* of the microscopic structures. This is beautifully seen in some silicified wood brought from Australia by Dr. Hooker, parts of which are so friable, that microscopic sections may be obtained by splitting it with a knife (Pl. 19. fig. 33). With solid silicified wood, sections made by the lapidary are required. We have also readily detected the structure in COAL by the process we have given under that head.

The only case of a structure approaching near enough to that of Coniferous wood to lead to misconception, appears to be that of the wood of certain Magnoliaceæ, such as *Drimys*, *Sphærostema*, and *Tasmannia*, where there is likewise absence of ducts and vessels, while the prosenchymatous cells have bordered pits; but the wood differs considerably in the character of the medullary rays, and in the number and arrangement of the pits on the walls of the cells. (See WINTEREÆ).

The wood of many of the Conifers is traversed by turpentine-canals, which are large intercellular passages bounded by thin-

walled cells; in others these occur only in the bark, while in *Taxus* and *Torreya* both are devoid of them; where none occur in the wood, there are generally isolated rows of cells filled with secretions, but not even these occur in the wood of *Abies pectinata*.

The following analysis of the structure of the wood of some of the most important, is modified slightly from Hartig:—

A. *Cells of the pith with thin walls.*

a. *Liber-cells in cross-section broad and mostly short, isolated, in scattered groups, or in bands of several rows, or wanting* .... ABIETINEÆ.

*Wood with turpentine-canals.

†Medullary rays with varying pits *Pinus.*

††Medullary rays with uniform pits.

‡Cords of secretion-cells at the outer limit of the annual rings.

§Outer wood-cells of the annual rings smooth within... *Cedrus.*

§§Outer wood-cells of the annual rings with an obscure spiral fibre .... *Larix.*

‡‡Wood without isolated rows of secretion-cells.................. *Picea.*

**Wood without turpentine-canals.

†Medullary rays with distant pits.

‡Wood-cells with distant pits, 1 or 2 rows in pairs .... *Abies.*

‡‡Wood-cells with crowded pits, 1–5 rows, in spiral arrangement.

§Wood without cords of secretion-cells.................... *Araucaria.*

§§Wood with cords of secretion-cells .... *Cunninghamia.*

††Medullary rays with crowded pits .... *Dammara.*

b. *Liber-cells with square or oblong cross-section, in concentric rows, alternating with parenchymatous cells*.. TAXINEÆ and PODOCARPEÆ.

*Pith with thick-coated liber-cells . *Salisburia.*

**Pith without thick-coated liber-cells.

†Wood-cells with openly-coiled spiral fibre .... *Taxus.*

††Wood-cells smooth within.

‡Liber-layers with thick-coated cells .... *Podocarpus.*

‡‡Liber-layers without thick-coated cells .... *Dacrydium.*

B. *Cells of the pith with thick walls, liber-cells square*..................... CUPRESSINEÆ.

*Liber-cells without pit-canals.

†Pith with a roundish cross-section, bark without turpentine-canals.................................... *Taxodium.*

††Pith with quadrangular cross-section, bark with turpentine-canals.................................... *Thuja.*

**Liber-cells with pit-canals.

†Wood-cells smooth inside.

‡Pith 3-angled........................ *Juniperus.*

‡‡Pith 2- or 4-angled.............. *Cupressus.*

†Wood-cells with a spiral fibre, like *Taxus* .... *Callitris.*

BIBL. Göppert, *De Conifer. Struc.* Vratisl. 1841; *Anat. Magnoliac.* Linnæa, xvi. p. 135, *Ann. des Sc. Nat.* 2 sér. xviii.; Hartig, *Botan. Zeit.* vi. p. 123, 1848; Schacht, *Die Pflanzenzelle*, Berlin, 1852, p. 435.

CONIOCAR'PON, D.C. (*Spiloma*, Hook. *Br. Fl.*).—A genus of Graphideæ (Gymnocarpous Lichens) closely related to *Arthonia*, but distinguished by the upper surface of the apothecia breaking up into powder.

BIBL. Leighton, *Ann. Nat. Hist.* 2 ser. xiii. 443, pl. 8.

CONIO'CYBE, Ach.—A genus of Lichens, tribe Caliciei, distinguished by the yellow powdery thallus, globose yellow powdery stipitate head-like apothecia, and colourless spores.

5 European, 3 British species.

BIBL. Leighton, *Lich. Fl. G. B.* p. 46.

CONIOMYCE'TES.—An order of Fungi composed of microscopic forms, for the most part parasitical upon plants, growing beneath the epidermis, or overgrowing decaying vegetables, and then more or less imbedded in the matrix. The fructification consists of groups of sessile or stalked spores (*sporidia*, Fries, and *stylospores*, Tulasne) arising from the filamentous mycelium. In the simplest forms the mycelium consists of short filaments, which are more or less completely converted into spores; or it forms an irregular flocculent patch in decaying matter or under the epidermis of plants, in which the spores are found intermingled, breaking out on the surface of the epidermis in the parasites; but in the more complete forms the mycelium becomes organized into firm structures of definite form (*conceptacles*) which are hollow, the walls being lined with short filaments terminating in spores. These conceptacles are either produced on the surface of the epidermis of the plant infested, or they are formed internally, and are exposed by breaking their way through to the surface of the epidermal structures in which they are imbedded.

We must not omit, in giving a description of this order as it stands in systematic works, to notice that recent observations go to prove that it rests upon a very insecure basis, and that certain supposed genera belonging to it appear to be merely forms of genera which exhibit at other stages of growth, or even at the same time, asciferous structures which have formed the bases of Ascomycetous genera. The following is a summary of the most recent views of Tulasne on these points:—The Hypoxylous

Fungi possess at least four distinct kinds of organs of reproduction, among which the *conidia* hold the first rank; these are bodies of various forms arising directly from the mycelium, or from the *stroma* which is formed upon this. Conidiiferous forms of Sphæriacei, which have been regarded as autonomous Fungi, have given origin to the following genera of this order:—*Melanconium, Stilbospora, Steganosporium, Coryneum, Exosporium, Cylindrosporium, Macrosporium, Vermicularia, Mystrosporium, Cladosporium, Helminthosporium, Periconia, Polythrincium, Tubercularia, Stilbum, Atractium, Graphium.* The *stylospores* are the naked and primitively stipitate spores formed in the conceptacles, called by Tulasne *pycnidia*; he regards as pycnidial forms of Sphæriacei most of the species of the genera *Diplodia, Sporocadus, Sphæropsis, Hendersenia, Myxocyclus, Phyllosticta, Phoma,* and their allies. These forms almost always occur united with the perfect or Ascomycetous forms to which they are to be referred. A *third* kind of acrogenous bodies occur often in the same conceptacles as the stylospores, but are much smaller, ordinarily of linear form, and are usually confounded ultimately into a gelatinous mass; these are the *spermatia,* which are supposed to exercise a fertilizing influence. The genera *Cytispora, Nemaspora, Libertella, Septoria, Cheilaria, Leptothyrium,* &c., are chiefly based on the *spermogonous* apparatus of Sphæriacei. The *fourth* form of spore is found enclosed in *asci*; the presence of these *ascospores* forms the basis of the class *Ascomycetes.* Further details are given under the heads of the families, and genera there referred to.

The Uredinei exhibit similar polymorphism, since the genera there included, such as *Æcidium, Puccinia,* based upon the most perfect form of fruit, mostly exhibit also a stylosporous form (on which is founded the false genus *Uredo*), together with *spermogonia* containing *spermatia.*

Synopsis of the Families.

1. Sphæronemei. Conceptacles rising from microscopic mycelium growing beneath the epidermis of leaves, bark, stems, &c., containing a chamber lined by a perithecium bearing single, often septate spores, and bursting by a spore at the summit. (Many are stylosporous forms of Ascomycetous genera.)

2. Melanconiei. Conceptacles as in the preceding, but without a proper perithecium; spores elongated. (Many are stylosporous forms of Ascomycetous genera.)

3. Phragmotrichaceæ. Conceptacles horny, breaking through the epidermis of leaves, &c., at first closed, afterwards bursting longitudinally; spores septate, and in chain-like series, intermixed with paraphyses on the internal walls of the conceptacles.

4. Torulacei. Mycelium filamentous, growing on the surface of decayed vegetables, bearing erect filaments, terminating in rows of simple or compound spores.

5. Uredinei. Mycelium a filamentous mass growing in the interior of living vegetable structures, finally breaking out on the surface in patches, margined or naked, and bearing simple or compound spores, single or in beaded series.

6. Ustilaginei. Mycelium filamentous, growing in the interior of organs of plants, producing simple or septate spores, finally breaking up, without bursting through to the surface, so as to leave a cavity full of dust-like spores.

Bibl. Berkeley and Broome, *Hooker's London Journ. of Bot.* iii. p. 320; Tulasne, *Compt. Rendus,* March 1851 (*Ann. Nat. Hist.* 1851, viii. p. 114); *Ann. des Sc. Nat.* 3 sér. xv. 370; *ibid.* xx. 129; *ibid.* 4 sér. ii. p. 77, v. p. 108; *Botan. Zeit.* xi. 49 *et seq.*; *Compt. Rendus,* 1854 (*Ann. Nat. Hist.* 2 ser. 1854, p. 76); Fries, *Syst. Mycol.*; De Bary, *Brand-pilze,* Berlin, 1853.

CONIO'PHYTUM, Hassall (*Dolichospermum,* Ralfs).—A genus (?) of Nostochaceæ (Confervoid Algæ), consisting of one species, colouring large sheets of water of a deep coppery green, by its minute fronds, each composed of a number of filaments variously curled and interwoven, densely in the centre, and more loosely towards the circumference; these fronds being free, look like a pulverulent or granular accumulation in the water, when viewed by the naked eye. This genus differs from its allies in the relative positions of the spermatic and vesicular cells, the former being either next to, or at a distance from the latter. This fact seems to throw some doubt on the value of this character as a distinctive mark.

C. Thompsoni, Ralfs = *Dolichospermum Thomp.,* Ralfs, *Ann. Nat. Hist.* 1850, v. 336, pl. 9. fig. 3. *Anabaina Flos-aquæ,*

Harvey, *Brit. Algæ*, ed. 1; Hassall, *Brit. Fr. Algæ*, t. 75. f. 2. See Hassall, *Bot. Gaz.* Aug. 1850 (*Colour of the Serpentine*).

CONIOTHE'CIUM, Corda.—An obscure genus of Torulacei (Coniomycetous Fungi), the so-called species being probably forms of some other Fungi.

C. amentacearum, Cda., is extremely common on dead willow twigs.

BIBL. Berk. and Broome, *Ann. Nat. Hist.* 1850, v. 460; Corda, *Ic. Fung.* i. figs. 21, 25, 26; Fries, *Summa Veget.* 523.

CONIOTHY'RIUM, Corda.—A genus of Sphæronemei (Coniomycetous Fungi).

C. glomeratum, Corda, recorded by Berkeley and Broome as British, is said by Fries to belong to his genus *Clisosporum*. It is a microscopic plant growing in the cracks of dead wood (elm), composed of minute free membranous peridia enclosing numerous spores, which escape by the bursting of the apex.

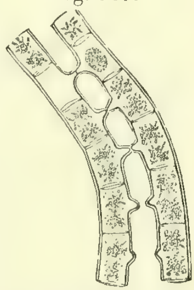
BIBL. Berk. and Broome, *Ann. Nat. Hist.* 1854, xiii. 460; Corda, iv. f. 208; Fries, *Summa Veget.* 522; Montagne, *Ann. des Sc. Nat.* 3 sér. xii. 304.

CONJUGA'TION or ZYGO'SIS.—A process occurring among some of the lower plants and animals, in which the substance of two distinct organisms comes into contact and becomes fused into a single mass, or zy'goite. This operation is always connected with reproduction in plants, and sometimes also in animals.

In the vegetable kingdom it has been observed in the Algæ, viz. in the Zygnemaceæ, the Desmidiaceæ, the Diatomaceæ, the Palmellaceæ, and in one genus of Fungi, viz. *Syzygites*. In all these cases it consists essentially in the blending together of the contents of two distinct cells, either by the complete fusion of two free cells, by the passage of the contents of one cell into the cavity of another through newly-formed connecting tubes, or by the emission of the contents of both cells into a space between them, where the mixed contents become enclosed in a special envelope.

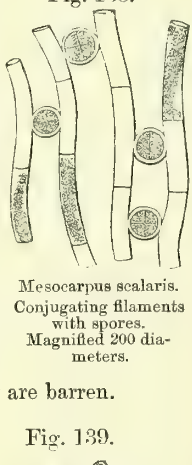
The conjugation earliest discovered was that of the Zygnemaceæ, in which the cells of distinct filaments lying parallel with one another, become united by lateral inosculation or by cross branches, formed by the budding out of the walls of the cells opposite to each other, the protruded processes coming into contact, cohering and becoming confluent by the absorption of the surfaces of contact (fig. 137). The cavities of the two cells being thus freely opened into one another, the contents become mixed; in *Spirogyra* and *Zygnema* the contents of one of the cells usually travel across into the cavity of the other (Pl. 5. fig. 18); in *Zygogonium* the contents of both cells collect in the cross-piece, this is the case also in *Mesocarpus* (fig. 138) and *Staurocarpus*, in the latter of which the cross-piece becomes greatly enlarged. The contents in all these cases become retracted from the cell-wall, and, secreting special coats, become spores, which escape by the rupture of the conjugated cells. In *Mougeotia* (fig. 139) there is no cross branch. The filaments become angularly bent and inosculate at the angles. A spore is said to be formed in each cell here. (See ZYGNEMACEÆ.)

Fig. 137.



Zygnema cruciata. Conjugating filaments. Magnified 250 diameters.

Fig. 138.



Mesocarpus scalaris. Conjugating filaments with spores. Magnified 200 diameters.

Pseudo-spores are sometimes formed in the cells of Zygnemaceæ without conjugation, in which case they are barren.

In the Desmidiaceæ the process presents a number of modifications. In the filamentous forms, such as *Hyalotheca* and *Didymoprium*, conjugation does not usually take place until the single cells of the filaments have become separated, but in some cases, as in *D. Borreri*, conjugation of the filamentous groups has been observed; perhaps this occurs in *Des-*

Fig. 139.

Mougeotia genuflexa. Conjugating filaments. Magnified 100 diameters.

midium also. In *Closterium, Penium, Tetmemorus, Cosmarium,* &c., the free cells conjugate in pairs. In almost all these cases the mode of union appears to be different from that which is seen in Zygnemaceæ, for the external membrane dehisces more or less completely, so as to separate the parent-cells into two valves, while a delicate internal membrane previously lining this is protruded as a sac, to meet its fellow from the corresponding conjugating individual; these sac-like processes coalesce, and thus the contents of the cell are enabled to mix. In *Hyalotheca dissiliens* and *Penium Brebissonii*, there is said to be union of the primary or outer cell-coat, as in *Zygnema.* The resulting spore or sporangium is mostly formed in the connecting piece (*Closterium, Cosmarium, Tetmemorus, Hyalotheca*) (Pl. 6. figs. 1–3), or in one of the cells (*Didymoprium Grevillii*, and perhaps in *Desmidium*). In *Closterium lineatum* it has been observed that the conjugating cells divide completely by constriction of their delicate internal membrane, just before conjugation, so that the dehiscent primary membranes emit from each parent individual a pair of little sacs in close apposition, and these meeting their fellows, a double or *twin* conjugation takes place, and a *pair* of spores or sporangia are formed. A gelatinous investment is secreted around the conjugating sac-like processes, and the spore is generally at first imbedded in an abundant gelatinous coat. (See DESMIDIACEÆ.)

In the Diatomaceæ there does not appear to be any delicate internal membrane, like that of the Desmidiaceæ, concerned in the conjugation. The two conjugating individuals, lying near together, become connected together by the excretion of a collection of gelatinous substance; the siliceous coats then dehisce, and the contents of the parent-cells, escaping from the valves, meet between them to unite into a globular mass, which does not become a spore, but gradually acquires the form of the parent. There is no connecting tube here; only the investing gelatinous matter. In *Himantidium* and *Surirella*, one new individual is formed in the conjugation (Pl. 6. fig. 4); in *Eunotia, Cocconema, Gomphonema* and *Schizonema*, the contents of the parent-cells appear to divide *transversely* before extrusion, and thus form a pair of new individuals in the conjugation (Pl. 6. fig. 5) (as in the case of the spores of *Closterium lineatum*). A peculiar condition occurs in other genera, *Cyclotella, Melosira*, &c., which is supposed to be a conjugation of the divided contents of one frustule. (See DIATOMACEÆ.)

Among the Palmellaceæ, conjugation has been observed in *Coccochloris Brebissonii* (*Palmoglœa macrococca*, Braun), where two vegetative cells become completely fused, membrane and contents, to form a spore which acquires a firm coat and oily contents, and passes through a stage of rest before recommencing vegetative development (Pl. 3. fig. 6 *c, d*).

The conjugation of the zoospores of *Pandorina* is noticed under that genus.

The supposed conjugation of VAUCHERIA and similar phenomena in some other Confervoids are cases of fecundation of sporangial cells by *unlike* antheridial cells, no permanent union taking place.

The only known case of conjugation in the Fungi, that described by Ehrenberg in SYZYGITES, a genus of Mildew Fungi, is described under that head.

De Bary, Tulasne and others have observed in several Fungi, as *Erysiphe, Pyronema, Peronospora*, &c., a sexual process which is exactly analogous to what takes place in certain Algæ, and in the abnormal Saprolegniæ, the body containing the male element coming in contact with the female organ, and thus producing fruit. This process seems rather to come under the term Copulation than Conjugation.

The conjugation observed in the animal kingdom, consists in the direct union, by a more or less extensive, sometimes complete, fusion of the substance of 2, 3, 4 or more distinct individuals. In *Diplozoon paradoxum* the two individuals become united by a cross branch; and the remarkable result is that sexual organs become developed on both bodies after this. Apparent conjugation takes place also in *Actinophrys, Acineta, Gregarina*, &c. It is, however, most probable that the fusion which occurs in many of these cases is spurious, and unconnected with reproduction.

Podophrya pyrum is one of the best instances of true conjugation, the resulting compound individual containing 8 embryos in a single cavity common to both. The true process has also been observed in *Acineta* (*mystacina*), *Vorticella* (*microstoma*), &c. And the researches of Balbiani show that in many of the Infusoria the conjugation is a true sexual process.

BIBL. Vegetables: Vaucher, *Hist. des Conferves*; Meyen, *Pflan.-phys.* iii. 413;

Hassall, *Brit. Algæ*; Kützing, *Phyc. gen.*; Ralfs, *Brit. Desmid.*; Morren, *Ann. des Sc. Nat.* 2 sér. v. 257; Smith, *Brit. Diat.*; Thwaites, *Ann. N. H.* xx. and ser. 2. i. and iii.; Braun, *Rejuv. in Nature* (*Ray Society*, 1853); Focke, *Physiol. Studien*, ii. 1854; Nägeli, *Algen-syst.* p. 175; Karsten, *Bot. Zeit.* x. p. 89 (1852); Ehrenberg, *Verhandl. Naturf. Freund.* i. 98 (1829); Areschoug, *Swed. Trans.* 1853; *Bot. Zeit.* xiii. p. 364; De Bary, *Conjugatæ*, 1859; Griffith, *Ann. Nat. Hist.* 2 ser. xvi. p. 92; Carter, *ibid.* xvii. p. 1; Hoffmann, *Phys. Bot.* ii. p. 155 &c.; De Bary, *Ann. d. Sc. N.* 1866, p. 343; Tulasne, *l. c.* 1866, p. 211. Animals: Kölliker, *Sieb. u. Köllik. Zeitsch.* i. pp. 1, 198 (*Qu. Mic. Jn.* i. p. 98); Siebold, *ibid.* i. p. 270, iii. p. 62; Stein, *Infus.*; *Wiegmann's Archiv*, 1849, p. 147; Nordmann, *Mikr. Beiträge*, i. p. 56; Clapar. & Lachm. *Infus.* ii. p. 222.

CONJUNCTI'VA. See Eye.

CONOCEPH'ALUS, Hill. See Fegatella.

CONOCHI'LUS, Ehr.—A genus of Rotatoria, of the family Œcistina.

Char. Animals aggregated around a central gelatinous nucleus, and forming a revolving sphere; two persistent frontal eyespots.

From ten to forty in each sphere. Nucleus sometimes green, from the presence of parasitic monads. Four thick conical papillæ arise from the middle of the frontal surface, each having a bristle at its apex.

C. volvox (Pl. 34. figs. 15–17). Carapace and body white, gelatinous, and hyaline; length 1-60″, breadth of sphere 1-8″. Aquatic.

Bibl. Ehr. *Infus.* p. 393.

CO'NODONTS.—Minute, slender, conical, curved, brownish bodies, found in a sandy Lower Silurian clay near Petersburg, and supposed by Pander to be minute fish-teeth, but by others to be spines of small Crustaceans, or the hooklets and denticles of Naked Mollusks and Annelides. They occur also in later strata.

Bibl. Pander, *Mon. foss. Fische*, &c., 1856; Murchison, *Siluria*, 1859, p. 375, and 1867, p. 356.

CONOS'TOMUM, Sw.—A genus of Bartramiaceous Mosses, with one British species: *Conostomum boreale*, Sw.

CONULI'NA, D'Orb.—A top-shaped, many-chambered, stichostegian Foraminifer, having the septal face slightly convex and multiperforate, is the only recorded sample of this doubtful genus, which is probably related to *Lituola*.

Bibl. D'Orb. *Foram. Cuba*, 1839.

CONULI'TES, Carter.—A Foraminifer of the *Globigerinida* family, and closely allied to, if not the same as, *Patellina*.

Bibl. Carter, *Ann. N. H.* ser. 3. viii. 457; Carpenter, *Introd. For.* 233.

COPPER.—Crystals of metallic copper exist in artificial Avanturine. The acetate of copper is noticed under Acetic acid.

The ammoniuret of copper is prepared by digesting copper turnings in an open bottle, with *Liq. Amm.* (P. B.); it must be used fresh. Its action is well displayed when it is brought into contact with cotton-wool.

COPPI'NIA, Hass.—A genus of Hydroid Polypes, fam. Coppiniidæ.

Char. Cells long, crowded, united by a cellular mass at their bases; ova developed in the cavities of the cellular mass.

C. arcta. Incrusting the stems of other zoophytes; common; greenish yellow.

Bibl. Hassall, *Mic. Tr.* iii. p. 160; Hincks, *Brit. Zooph.* p. 219.

CO'RA, Fr.—A tropical genus of Lichens, approaching *Coccocarpia*.

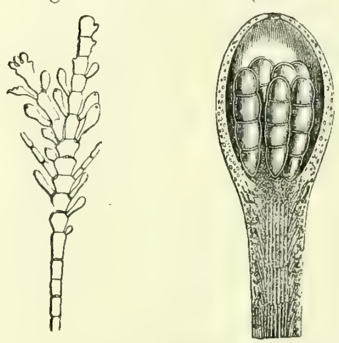
1 species: *C. pavonia.*

Bibl. Fries, *Syst. Orb. Veg.* p. 300; Nyl. *Ann. d. Sc. Nat.* 1855, iii. p. 151.

CORAL.—A term applied in general to the calcareous polypidom or skeleton of Polypes or Zoophytes, and in particular to that of Corallium.

CORAL'LINA, Linn.—A genus of Corallinaceæ (Florideous Algæ), of stony cha-

Fig. 140. Fig. 141.



Corallina officinalis.

Fig. 140. A branch of the frond. Natural size.
Fig. 141. A section of the end of a branch terminating in a ceramidium, containing tetraspores. Magnified 10 diameters.

racter, looking like corals. The common species, *C. officinalis*, grows everywhere between tide-marks, on rocks, &c., and presents a branched, mostly pinnate tuft of articulated filaments evenly coated with carbonate of lime. The tetraspores are borne in tufts in ceramidia (fig. 141), usually at the apices of the branches (being the last joints transformed), or they occur laterally (fig. 140), sometimes in pairs and sometimes irregularly over the whole frond; they open by a small terminal pore (fig. 141).

The structure may be examined in these plants by keeping them for some time in vinegar or dilute muriatic acid, which will remove the lime and allow of the substance being sliced in the same way as other Algæ.

BIBL. Harvey, *Br. Mar. Alg.* pl. 13 C; *Phyc. Brit.* pl. 222; Decaisne, *Ann. des Sc. Nat.* 2 sér. xvii. pl. 17. fig. 1. xviii. p. 119.

CORALLINA'CEÆ.—A family of Florideæ. Rigid, articulated, or crustaceous, mostly calcareous sea-weeds, purple when fresh, fading, on exposure, to milk-white; composed of closely-packed elongated cells or filaments, in which carbonate of lime is deposited in an organized form. *Tetraspores* tufted, contained in ovate or spherical *conceptacles* (*ceramidia*, Harvey), furnished with a terminal pore. British genera:

* *Frond filiform, articulated* (Corallineæ).

1. *Corallina. Frond* pinnated. *Ceramidia* terminal, simple.

2. *Jania. Frond* dichotomous. *Ceramidia* tipped with two horn-like ramuli.

** *Frond crustaceous or foliaceous, opaque, not articulated* (Nulliporeæ).

3. *Melobesia. Frond* stony, forming either a crustaceous expansion, or a foliaceous or a shrub-like body.

4. *Hildebrandtia. Frond* cartilaginous, not stony, forming a crustaceous expansion.

*** *Frond plane, hyaline, composed of cells radiating from a centre. Fructification unknown* (Lithocysteæ).

5. *Lithocystis* (a minute parasite).

CORALLINES.—The Corallinaceæ, a family of Algæ, were formerly imagined to be of animal nature, and were classed among the Zoophytes. On the other hand, Ellis applied the term *Coralline* more extensively, including under it Polyzoa (Bryozoa), and Sertularian and similar Zoophytes (Polypes): the name is still often vulgarly used in this sense. The term should properly be restricted to the family to which the genus *Corallina* gives the name. See CORALLINACEÆ and POLYPI.

CORAL'LIUM, Lam.—A genus of Polypes, of the order Anthozoa.

The red coral of commerce is the internal skeleton of the *Corallium rubrum*, Lam. (*Isis nobilis*, Lin.) (Pl. 33. fig. 6 *c*). A portion of the dried animal matter is usually found adhering to its surface, and contains abundance of spicula (Pl. 33. fig. 7).

The furrows seen upon the outer surface of unprepared coral, are the impressions of vessels which traverse the cortical substance and form a medium of communication between the various polypes.

The structure of coral is rather obscure. The transverse section (Pl. 33. fig. 8 *a*) exhibits somewhat undefined lines, some o which are semiconcentric with the marginal furrows, and appear to be lines of growth; these are intersected by darker and narrower lines, apparently canals. The orifices of larger canals are also visible. The longitudinal section (Pl. 33. fig. 8 *b*) exhibits longitudinal lines, probably those of growth, with an indistinct intermediate structure. When treated with acid, the residue is soft and easily folded so as to produce a lined appearance; and in parts the organic skeletons of spicula may be distinguished. Hence it probably consists of spicula, aggregated and ultimately consolidated, so that their structure is no longer distinguishable.

BIBL. Cuvier, *Règne Animal* (1853?), *Zoophytes*; Lacaze-Duthiers, *Hist. Nat. d. Corail.* 1864; Dana, *Corals &c.* 1872.

COR'DYCEPS, Fries.—See SPHÆRIA and CLAVICEPS.

CORDYLO'PHORA, Allman.—A genus of Polypes, of the order Hydroida, and family Clavidæ. Aquatic.

Char. Polypidom horny, branched, rooted by a creeping tubular fibre; branches tubular; polypes existing at the extremities of the branches, ovoid, the mouth at the distal extremity, and furnished with scattered filiform tentacula.

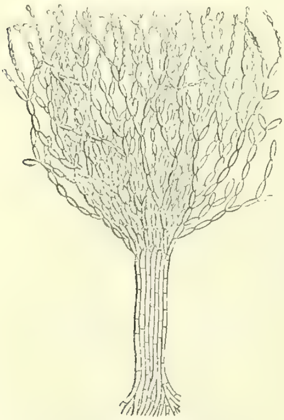
C. lacustris, the only species; height 2–3 inches. The only compound Polype found in fresh water.

BIBL. Allman, *Ann. Nat. Hist.* xiii. p. 330; and *Phil. Trans.* 1853; Johnston, *Brit. Zoophytes*, p. 44; Hincks, *Brit. Zooph.* p. 15.

COREMIUM, Link.—A false genus of Mucedines (Hyphomycetous Fungi), not

really distinct from PENICILLIUM, but differing from the characteristic form of that genus in having the erect fertile filaments compacted into a kind of cellular pedicle to bear the strings of spores (fig. 142). *C. leucopus*, Pers.; filaments white, spores green; not uncommon on decaying fruits, &c. = *Floccaria glauca*, Grev. *Sc. Crypt. Fl.* t. 301, and is *Penicillium crustaceum β*, Fries. *C. candidum*, Nees; filaments and spores white; on decaying substances, is *Penicillium candidum β*, Fries.

Fig. 142.



Coremium niveum, Corda.
Magnified 200 diameters.

BIBL. Hook. *Brit. Fl.* v. pt. 2. 344; Fries, *Syst. Mycol.* iii. 408; Greville, *loc. cit.*; Corda, *Icones Fung.* ii. pl. 11. fig. 73; *Prachtflora*, pl. 25.

CORETH'RA, Meig.—A genus of Dipterous Insects, of the family Tipulidæ.

The larva of *C. plumicornis* forms a beautiful microscopic object; it inhabits fresh water.

BIBL. Karsch, *Monog. d. Coreth. plum.*; Ray Lankester, *Pop. Sc. Rev.* 1865; Leydig, *Sieb. & Köll. Zeitsch.* iii. p. 435; Rymer Jones, *Mic. Trans.* 1866, p. 99; Weismann, *Sieb. & Köll. Zeitsch.* 1866, p. 45.

CORETH'RIA, Wright.—A genus of Rhizopoda, family Actinophryina (?). Body oblong, with a long club-shaped appendage, bearing a thick brush of 8–40 tentacles at its summit.

C. sertulariæ. On *Sertularia pumila.*

BIBL. Pritchard, *Infus.* p. 563.

CORIN'NA, Heib.—A genus of Diatomaceæ.

Char. Frustules punctate-areolate, united into semicircular fasciæ, angles produced, spiniferous, the uppermost longest, intermediate portion hemispherical, with septa; valves ellipsoidal, transversely bicostate, apiculate at each end.

C. elegans. Shores of Denmark.

BIBL. Heiberg, *Consp. Diat.* 1863, p. 53, pl. 3. fig. 8.

CORK.—Ordinarily the outer layer of bark of the Cork Oak (*Quercus Suber*), for the development of which, see BARK. Horizontal and transverse sections of the large light-coloured cells of cork are shown in Pl. 38. fig. 16 and 17. The term cork is applied generally to excessive developments of the *suberous layer* of barks.

CORN.—The general name applied to the seeds, or rather the fruits of the various plants furnishing the ordinary materials for bread. These all belong to the Monocotyledonous family, Graminaceæ (Grasses); for Buck-wheats cannot be considered as true corn. The grains of the Grasses are enveloped in the adherent pericarp, which is dry and smooth; the seed which this encloses is characterized by the presence of a comparatively large *mealy* albumen, composed of thin-walled parenchyma, more or less densely filled with starch, which makes up the great body of the grain; a few layers of cells subjacent to the surface, however, contain little starch, but abundance of nitrogenous protoplasmic matter, or *gluten*. These layers containing the greater proportion of the gluten, together with epidermis, are removed from fine flour in grinding, as the bran and pollard, the fine white flour consisting chiefly of the starch. The forms of the starch-grains differ considerably, as also their condition in the cell. In Wheat (*Triticum*), the starch-grains are lenticular (Pl. 36. fig. 8), and lie loose in the cells; in Barley (*Hordeum*), they are very similar, but the larger grains are squarish and thinner (Pl. 36. fig. 9); in Oats (*Avena*), polygonal, but compacted together into roundish masses (Pl. 36. fig. 10.); in Rice (*Oryza*), the starch-grains are very small, and packed so closely together that they press upon one another, thus acquiring a parenchymatous form (Pl. 36. figs. 12 & 13); and then, as they adhere firmly together, the contents of the cells appear like one solid mass; hence the horny character of the grains of rice, and the grittiness of rice-flour. In Maize (*Zea*), the outer part of the grain is horny from the same cause as rice, and presents a similar

appearance (Pl. 36. fig. 3), but in the centre the cells are often less densely filled, and the grains lie more or less loose (Pl. 36. fig. 5). For further particulars of the characters of the starch-grains, see STARCH.

CORNICULA'RIA, Ach.—A genus of Parmeliaceæ (Gymnocarpous Lichens) composed of rigid tufted plants, the lobes of the thallus standing up in forked horn-like processes. Most of the species occur on the ground or rocks on high mountains.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 232; *Engl. Botany*, pl. 452, 720, 846, &c.; Lindsay, *Br. Lich.* p. 127.

CORNS consist of thickened epidermis, the scales being increased in number, much flattened, and closely aggregated from pressure. This is the structure in their simplest form. When larger, they represent an ordinary blister, conjoined with the thickening of the epidermis; hence the origin of the cavity in the centre of many of them. The papillæ of the cutis are generally hypertrophied. The epidermic scales may be rendered distinct by digestion with acetic acid or solution of potash.

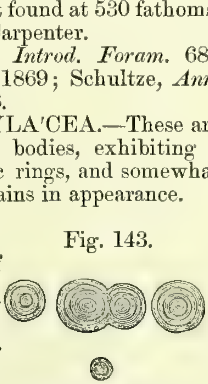
CORNUSPI'RA, Schultze.—This genus, restricted, comprises the planorbiform *Miliolida*, which, commencing with a somewhat agathistegian growth, soon become discoidal and non-segmented.

C. foliacea (Pl. 18. fig. 13) is a common Foraminifer, white and opaque, with the whorls rapidly increasing in width in the adult state. It has abounded from the older Tertiary times to the present, chiefly in shallow water, but found at 530 fathoms, North Atlantic, by Carpenter.

BIBL. Carpenter, *Introd. Foram.* 68; *Proc. R. Soc.* June 1869; Schultze, *Ann. N. Hist.* 1861, p. 306.

COR'PORA AMYLA'CEA.—These are microscopic rounded bodies, exhibiting a number of concentric rings, and somewhat resembling starch-grains in appearance. They are found in the *fornix*, the *septum lucidum*, the walls of the ventricles, and the cortical substance of the brain, the medullary substance of the spinal cord, the waxy spleen, &c. They are but little acted upon by dilute acids; caustic alkalies render them more transparent, and gradually dissolve them. Solution of iodine gives them a bluish tinge; and the subsequent addition of sulphuric acid produces the bluish-violet colour seen when cellulose is treated with these reagents. The reaction is best seen when the action of the acid takes place slowly. Hence these bodies have been regarded as consisting of amyloid or cellulose.

Fig. 143.



Magnified 350 diameters. Corpora amylacea, from the human ependyma.

The *corpora amylacea* must be distinguished from the concretions forming 'brain-sand,' or the *acervulus cerebri.* These are also rounded, single, or aggregated, usually exhibiting the concentric rings, sometimes forming cylindrical, ramified, or reticular fibres. They are met with in the choroid plexuses, the pineal gland, the arachnoid membrane, and sometimes in the walls of the ventricles. These consist of an organic (proteine) skeleton, containing carbonate and phosphate of lime. When treated with acids, the latter are dissolved, the former being left and retaining the original form of the concretions.

BIBL. Purkinje, *Müller's Archiv*, 1836 & 1845; Kölliker, *Mikr. Anat.* ii. pt. 2. 501; Virchow, *Archiv f. path. Anat. &c.* p. 135, 268, 416, and *Ann. Nat. Hist.* xii. p. 481; Green, *Pathology*, 1871, p. 71; Frey, *Histol.* p. 32.

CORPUS'CULA, of the Coniferæ. See GYMNOSPERMIA.

CORROSIVE SUBLIMATE, the bichloride of Mercury.—A saturated solution of this salt is very useful in rendering very transparent bodies consisting of proteine-compounds more opaque and distinct, as the bodies and cilia of Infusoria &c.

CORY'CIA, Duj. = *Amœba bilimbosa*, Auerbach (Duj. *Ann. d. Sc. N.* 1852, p. 41).

CORYMOR'PHA, Sars.—A genus of marine Hydroid Polypi, family Tubulariidæ.

BIBL. Hincks, *Brit. Zooph.* p. 125.

CORYNACTIS, Allman.—A genus of Anthozoa (Polypi).

1 species: *C. viridis.*

BIBL. Gosse, *Actinologia Britannica* (the latest work on *Sea-Anemones*).

CORY'NE, Gærtn.—A genus of marine Hydroid Polypi, family Corynidæ.

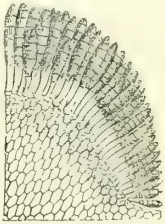
BIBL. Hincks, *Brit. Zooph.* p. 37.

CORY'NEUM, Kunze.—A genus of Melanconiei (Coniomycetous Fungi), consisting of parasitic plants growing upon dead twigs, bursting out as convex solid pustules from beneath the epidermis. A vertical section of half of one of these pustules is shown in fig. 144; the cellular stroma is covered by stalked multiseptate spores. Six forms

are recorded as British. That figured, *C. disciforme*, Kze., grows on dead twigs of birch.

Tulasne states this genus to consist of the conidiiferous form of *Melanconis* (Sphæriacei).

Fig. 144.



Coryneum disciforme. Vertical section of half a pustule. Magnified 200 diams.

BIBL. Hook. *Brit. Fl.* v. pt. 2. p. 355; Berk. & Broome, *Ann. Nat. Hist.* 2 ser. v. 458; Currey, *Qu. Micr. Journ.* v. p. 127; Tulasne, *Ann. des Sc. Nat.* 4 sér. v. p. 110; Corda, *Icones Fung.*

CORYNO'PSIS, Allman.—A genus of marine Hydroid Polypi, family Hydractiniidæ.

C. Alderi, Durham.

BIBL. Hincks, *Brit. Zooph.* p. 34.

COSCINODISCUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules free, single, disk-shaped; valves circular, flat, or slightly convex, exhibiting a cellular or areolar appearance. (No internal septa, nor lateral processes.)

The cellular appearance arises from the existence of depressions, which are of different sizes. The valves form beautiful objects.

Kützing enumerates forty-one species, which are either marine or fossil. Smith admits four British species.

C. minor, E. Depressions irregular and crowded (circular, Sm.); margin of valves smooth; aquatic and marine; diam. 1-1200 to 1-500''.

C. radiatus, E. (Pl. 18. fig. 32). Depressions obscurely radiating, marginal ones smallest; margin of valves smooth; marine and fossil; diam. 1-550 to 1-180'' (*a*, side view; *b*, front view).

C. eccentricus, E. Depressions arranged in curved lines, with the convexity towards the centre; marine and fossil; diam. 1-400 to 1-200''.

C. pyxidicula, Kg. (*Pyxidicula* and *Craspedodiscus coscinodiscus*, E.) (Pl. 43. fig. 21). Margin tumid, elegantly cellular, central areola very fine, diminishing towards the centre; no umbilical star; marginal cells hexagonal, larger; diam. 1-400''. Fossil. Virginia.

C. craspedodiscus, K. = *Craspedodiscus elegans*, E. (Pl. 19. figs. 7 & 8). Margin of valves tumid, elegantly sculptured, central markings (depressions) radiating; an umbilical star formed of 5 to 6 oblong larger cells (?); diam. 1-120''. Fossil. Bermuda.

BIBL. Ehr. *Abhandl. d. Berl. Akad.* 1838 and 1839; id. *Ber. d. Berl. Akad.* 1840 *et seq.*; Kützing, *Bacill.* and *Sp. Alg.*; Smith, *Brit. Diat.* 1; Wallich, *Qu. Mic. Jn.* 1860, p. 38; Greville, *Mic. Trans.* 1864, p. 9; 1865, pp. 25, 43; 1866, pp. 3, 78.

COSCINOSPI'RA, Ehrenberg. — The elongate subtype of *Peneroplis*, one of the *Foraminifera imperforata*. It is a synonym of *Spirolina*, Lamarck.

BIBL. Ehrenberg, *Berlin Acad. Transact.* 1839; Parker and Jones, *Ann. N. H.* ser. 3. v. 180.

COSMARIUM, Corda.—A genus of Desmidiaceæ.

Char. Cells single, constricted at the middle; segments as broad as or broader than long, neither sinuated nor spinous.

A peculiar swarming motion is observable at times in the cell-contents of this genus, different from the circulation in *Closterium*. From some observations by Mrs. Thomas, it appears likely that the spore-cell divides into numerous individuals in germination.

Rabenhorst describes 77 European species. Among the most common British species are :—

C. pyramidatum (Pl. 10. fig. 18, 19 empty cell). Oval, with depressed and truncate ends, deeply constricted; end view elliptical; segments punctate, entire; length 1-470 to 1-260''.

C. bioculatum. Smooth, depressed, constriction producing a gaping notch on each side; end view elliptical; segments subelliptic, entire; sporangium orbicular, spinous; length 1-1410''.

C. crenatum (Pl. 10. fig. 20). Punctate, deeply constricted; segments crenate at the margin, depressed at the end; end view elliptical; spines of sporangium very short; length 1-470''.

C. tetrophthalmum (Pl. 10. fig. 22). Deeply constricted; segments semicircular; end view elliptical; rough with pearly granules, which give a crenate appearance to the margin; length 1-230''.

C. margaritiferum (Pl. 10. fig. 21). Rough with pearly granules, which are as broad as long; end view elliptic; segments semicircular or reniform; length 1-560 to 1-300''.

C. ornatum. Segments twice as long as broad, rough with granules giving a

dentate appearance to the margin; end view with a truncate projection on each side; length 1-610″.

C. cucurbita. Punctate, constriction slight, ends rounded; transverse view circular; length 1-580″.

Lobb describes an extraordinary species, *C. radiatum*, the surface being covered by densely crowded hyaline filaments, like those of *Actinophrys*, but closer.

Bibl. Ralfs, *Brit. Desmid.* pp. 91 & 212; Thomas, *Trans. Mic. Soc.* new ser. iii. p. 33; Lobb, *Qu. Mic. Journ.* 1866, p. 55; Archer, *Qu. Mic. Jn.* 1860, p. 235, 1864, p. 178.

COSMIODIS'CUS, Grev.—A genus of fossil Diatomaceæ.

Char. Frustules simple, disk-shaped; valves radiato-punctate or areolar, with linear radiating spaces (no processes nor internal septa). 3 species: in Monterey and Barbadoes deposit.

Bibl. Greville, *Qu. Mic. Jn.* 1866, p. 79.

COSMOCLA'DIUM, Bréb.—A genus of Desmidiaceæ (Palmellaceæ, Rab.).

Char. Cells rounded, compressed, deeply constricted, attached to a branched stipe. Reproduction by gonidia.

C. pulchellum (Pl. 42. fig. 38), attached; in turfy pools.

2 other species (unattached).

Bibl. De Brébisson, *Liste d. Desm.* p. 133; Rabenhorst, *Fl. Alg.* iii. p. 53.

COTHURNIA, Ehr.—A genus of Infusoria, of the family Ophrydina (Vorticellina, subfamily Ophrydina, Cl. & L.).

Char. Solitary; carapace urceolate, stalked, fixed by the posterior extremity.

An anterior ring of cilia is present. The body contracts suddenly, like that of *Vorticella.*

Dujardin unites this genus with *Vaginicola.*

C. imberbis, E. (Pl. 25. fig. 20). Stalk much shorter than the hyaline carapace; body yellowish; aquatic; length of carapace 1-280″. Found upon *Cyclops quadricornis.*

C. maritima, E. Stalk much shorter than the carapace; body whitish, hyaline; length of carapace 1-570″. On *Ceramium.*

C. havniensis, E. Stalk much longer than the carapace; body whitish; length of carapace without the stalk 1-280″, stalk twice this length. On *Sertulariæ* &c.

Stein adds 3 species, *C. Sieboldii*, *C. astaci*, and *C. curva*; found upon *Astacus fluviatilis* (the Cray-fish). Cl. & L. describe 12 species, 4 new.

Bibl. Ehr. *Infus.* p. 297; Duj. *Infus.* p. 564; Stein, *Infus.*; Clap. & Lachm. *Infus.* i. p. 121.

COTTON.—The hairs from the epidermis of the seeds of various species of *Gossypium* (Malvaceæ, Dicotyledons). These hairs are readily distinguished, under the microscope, from the various textile fibres consisting of liber structures. From the absence of the regular thickening layers, the cells of the cotton-hairs become collapsed when dry, appearing like a flat band with thickened borders, while liber-cells of all kinds remain cylindrical, and taper to a point at each end (Pl. 21. fig. 1). See Fibrous Structures; and Mitchell, *Qu. Mic. Jn.* 1864, p. 218.

COVERS. See Introduction, p. xxii.

CRASPEDODIS'CUS, E.—A genus of fossil Diatomaceæ.

C. coscinodiscus, E. = *Pyxidicula coscinodiscus*, E. = *Coscinodiscus pyxidicula*, Kg. (Pl. 43. fig. 21).

C. elegans, E. = *Coscinodiscus craspedodiscus*, Kg. (Pl. 19. figs. 7 & 8).

Bibl. Ehr. *Ber. d. Berl. Ak.* 1844, p. 261–266; Kützing, *Sp. Alg.* p. 126; Greville, *Mic. Trans.* 1866, p. 79; Pritchard, *Inf.* pp. 831, 939.

CRASPEDO'PORUS, Grev.—A genus of Diatomaceæ.

Char. Frustules free, disk-shaped; valves with club-shaped rays, each with an ocellus near the margin.

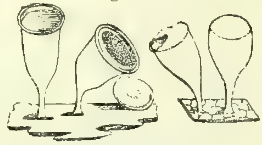
C. Ralfsianus. Valves areolar, rays 8; diam. $\frac{1}{220}$″. Barbadoes.

C. Johnstonianus. Rays 5; diam. $\frac{1}{400}$. Barbadoes.

Bibl. Greville, *Mic. Trans.* 1863, p. 68.

CRATERIUM, Trent.—A genus of Myxogastres (Gasteromycetous Fungi), consisting of minute yellow or brown cup-like bodies, of papery consistence, closed by a deciduous operculum (fig. 145), arising from an evanescent gelatinous mycelium, growing over moss, leaves, bark, &c. Most of the species are common. The black spores contained within these cups are intermixed with crowded, obscurely articulated filaments (destitute of spiral fibres), which do not anastomose, and are at length erect. Five species are described as British.

Fig. 145.



Craterium pyriforme.
Magnified 10 diameters.

Bibl. Hook. *Brit. Fl.* v. pt. 2. p. 316; Sowerby, *Fungi*, t. 239 (*C. minutum*, as *Cyathus minutus*).

CRATEROSPER'MUM, Braun.—A genus of Zygnemaceæ, with the green endochrome not in spiral bands. Conjugating filaments geniculate; sporange with a double cyst; the inner spherical, the outer thick, shortly cylindrical, subquadrate, with an annular furrow, and excavated at each pole.

C. lætevirens. In pools.

Bibl. Braun, *Alg. Unicell.* 1855, p. 60.

CREATINE or KREATINE.—Occurs in the juice of the flesh of Mammals, Birds, Amphibia and Fishes; also in human urine. It crystallizes from an aqueous solution, in transparent, highly refractive, oblique-rhombic prisms and needles (Pl. 7. fig. 22) belonging to the oblique-rhombic prismatic system.

Bibl. See Chemistry, Animal (Lehmann, Gorup-Besanez, Funke).

CREATININE or KREATININE.—Occurs in the juice of the flesh of Man and Mammals; probably in the amniotic liquid; also in human urine. The crystals form colourless prisms belonging to the oblique-rhombic prismatic system (Pl. 7. fig. 23).

Creatinine forms a crystallized compound with chloride of zinc (Pl. 7. fig. 24). This is very difficultly soluble in water, and not at all in alcohol or ether.

Bibl. See Creatine.

CRESSWEL'LIA, Grev.—A genus of fossil Diatomaceæ.

Char. Frustules cylindrical, cohering by short filiform (spine-like) processes into a continuous filament. Valves cup-like, areolar, destitute of siliceous connecting band (hoop).

C. turris. Clyde. Other species.

Bibl. Greville, *Edinb. Ph. Tr.* 1857, xxi. p. 538; *Mic. Tr.* 1861, p. 68; 1865, p. 4; 1866, p. 78.

CRIBRA'RIA, Schrad.—A genus of Myxogastres (Gasteromycetous Fungi), consisting of minute stalked capsules growing upon rotten wood &c. The capsules (peridia) are membranous; the upper part falls or decays off when the spores are mature, and the anastomosing filaments (capillitium) which are contained in the interior are confluent with the outer wall, where they form a permanent spherical cage or network (fig. 147), from the meshes of which the spores escape. The only species recorded as British is *C. intermedia*, Berk., intermediate between *C. vulgaris* and *C. aurantiaca.* The peridium is yellow with a white stalk; the spores yellow. (Figured as *Sphærocarpus semitrichioides* by Sowerby, t. 400. fig. 5.) To this have recently been added *C. argillacea*, *aurantiaca*, and *intricata.* They are very interesting microscopic objects.

Fig. 146.

Cribraria aurantiaca.
Natural size.

Fig. 147.

Cribraria aurantiaca.
Peridium burst, with the capillitium exserted.
Magnified 25 diameters.

Bibl. Hook. *Brit. Fl.* v. pt. 2. 318; Fries, *Syst. Mycolog.* iii. 168; Corda, *Icon. Fung.* v. pl. 3. fig. 35; Cook, *Handb.* p. 400.

CRICKET. See Acheta.

CRIS'IA, Lamx.—A genus of Infundibulate Polyzoa, of the suborder Cyclostomata, and family Crisiadæ.

Char. See Crisiadæ. Four species:

1. *C. eburnea.* Cells loosely aggregated, curved, ends free. Common.

2. *C. denticulata.* Cells loosely aggregated, nearly straight, joints black.

3. *C. aculeata.* Cells in two rows, armed with a spine, joints amber.

4. *C. geniculata.* Cells alternate, long and tubular, orifice plain.

Bibl. That of the family.

CRISIADÆ.—A family of Infundibulate Polyzoa, of the suborder Cyclostomata.

Distinguished by the plant-like jointed and branched polypidom, and the tubular cells in one or two rows, with round orifices mostly looking to opposite sides.

Cells and branches covered with dots (holes). Pear-shaped vesicles are met with on the polypidom, resembling those of the Sertulariadæ. Two genera unnecessarily separated:

1. *Crisia.* Cells in two rows, subalternate; orifices terminal and entire.

2. *Crisidia.* Cells in a single row, the ends free, diverging.

BIBL. Johnston, *Brit. Zooph.* 282.

CRISI'DIA, M.-Edw.—A genus of Infundibulate Polyzoa, of the suborder Cyclostomata, and family Crisiadæ.

Char. See CRISIADÆ. Two species:

1. *C.cornuta.* Cells curved, orifices turned one way, a long bristle above each cell.

2. *C. setacea.* Cells long, ends turned alternately in opposite directions; a long bristle below the orifice of each cell.

BIBL. That of the family.

CRISTATEL'LA, Cuv.—A genus of Polyzoa (Bryozoa), family Cristatellidæ.

Char. Polypary free, disk-shaped, polypiferous at the margin; tentacles numerous, pectinate upon two arms. Aquatic.

C. mucedo (Pl. 33. fig. 9). Three, four, or more polypes arise from the locomotive polypidom. Pseud-ova (statoblasts) in the young state enclosed in a ciliated membrane, disk-shaped, furnished with marginal spines which are hooked at the end (fig. 10), and opening with a lid.

In clear lakes and ponds, creeping over stones and the stems of aquatic plants; and occasionally in large numbers in the holes made by the feet of cattle around ponds. Length $1\frac{1}{2}''$, breadth $\frac{1}{4}''$.

BIBL. Cuvier, *Règne Animal*, 1817, iv. p.68; Turpin, *Ann. d. Sc. Nat.* 2 sér. vii. p.65; Gervais, *ibid.* vii. p. 77; Johnston, *Brit. Zooph.* p. 387; Varley, *Lond. Phys. Journ.* iii. p. 37; Allman, *Polyzoa* (*Ray Soc.*).

CRISTELLA'RIA, Lamk.—Among the hyaline Foraminifera grouped generically as *Nodosarina* and varying in mode of growth from straight and partially curved to discoidal, the *Cristellariæ* are the more symmetrically lenticular and nautiloid, varying, however, in outline and in thickness. The chambers, either triangular or falciform, are close-set and communicate at the outer angle. The shell is neat, often delicate, and ornamented on the margin with keel or *crest*, and on the sides with raised umbones, granulations, cross bars, and septal ridges.

Cristellaria is common in the Lias and all succeeding formations, very large in the Tertiary deposits of Italy; and not uncommon in existing seas. *C. simplex* (Pl. 18. fig. 34), feeble of growth, is present always with other *Cristellariæ*. *C. cultrata* (fig. 37) is a well-grown and typical form.

BIBL. D'Orbigny, *For. Foss. Vien.* 82; Morris, *Brit. Foss.* 33; Williamson, *Rec. For.* 24; Parker and Jones, *Ann. N. H.* 2 ser. xix. 209; 3 ser. iii. 477; v. 114; Carpenter, *Introd. Foram.* 162.

CRONAR'TIUM, Fries.—A genus of Uredinei (Coniomycetous Fungi), presenting the most perfect form of structure in that family. The spores are contained in a peridium, which bursts by a regular or irregular apical orifice. The perfect spores are produced on a columnar cellular body, called the ligule, which rises out of the centre of the Uredo-form or of its empty perithecium. *C. Vincetoxici* is the perfect form of *Uredo Vincetoxici.*

BIBL. Tulasne, *Ann. des Sc. Nat.* 4 sér. ii. p. 188.

CROUA'NIA, J. Agardh.—A genus of Cryptonemiaceæ (Florideous Algæ). *C. attenuata* is a very rare plant, which has been found epiphytic on *Cladostephus spongiosus.* Its frond consists of a single-tubed filament, with the joints clothed with dense whorls of minute dichotomously multiplied branchlets, somewhat beaded. The favellidia are stated to occur near the tips of the branchlets; the tetraspores (large) are affixed to the bases of the latter.

BIBL. Harvey, *Br. Mar. Alg.* pl. 21 D; *Phyc. Brit.* pl. 106; J. Agardh, *Alg. Medit.* 83; Agardh, *Sp. Alg.* ii. 136 (as *Griffithsia nodulosa*); Kützing, *Sp. Alg.* 651 (*Callithamnion*).

CRUCIB'ULUM, Tulasne.—A genus of Nidulariacei (Gasteromycetous Fungi).

C. vulgare occurs frequently on ferns, decayed sticks, &c., and is found in many parts of the world.

BIBL. Sachs, *Bot. Zeit.* xiii. p. 833; Tulasne, *Ann. d. Sc. N.* 1844.

CRUCILOCULI'NA, D'Orb.—A Triloculine *Miliola* with a crucial fissure for its aperture, that is, having four small symmetrical valves, instead of one. Known only from the Patagonian coast.

BIBL. D'Orb. *For. Amer. Mér.* 1839; Carpenter, *Introd. For.* 80.

CRUME'NULA, Duj.—A genus of Infusoria, of the family Thecamonadina.

Char. Oval, depressed, with a resisting obliquely striated or reticulated tegument, from a notch in the fore part of which a long flagelliform filament issues; a red eyespot. Movement slow.

C. testa (Pl. 23. fig. 34). Green; aquatic; length 1-510''. Filament three times as long as the body.

Dujardin appends *Prorocentrum,* E. to this genus.

BIBL. Dujardin, *Infus.* p. 339.

CRUOR'IA, Fries.—A genus of Cryptonemiaceæ (Florideous Algæ). *C. pellita* is

common on exposed rocks and stones between tide-marks, forming a glossy purplish skin, between gelatinous and leathery, upon smooth surfaces, in patches 2 to 3″ in diameter. This 'skin' is formed of vertical tufts of simple articulated filaments imbedded in a gelatinous matrix. One of the cells of each filament is larger than the rest. The tetraspores occur at the bases of the filaments.

Bibl. Harvey, *Br. Mar. Alg.* pl. 20 C; *Phyc. Brit.* pl. 117.

CRUSTA'CEA.—A class of Animals, belonging to the subkingdom Articulata.

Char. Apterous; no tracheæ; respiration aquatic (branchial), or effected by the skin: legs jointed. (A dorsal vessel, ventricle, or heart; integument composed partly of chitine.)

The *integument* of the Crustacea usually forms a hard calcareous shell, sometimes, however, being leathery or horny; it constitutes an external skeleton. In its most complex condition four layers are distinguishable:—an outermost, very thin, transparent and structureless or cellular—the epidermis; beneath this, a layer of pigment-cells to which the colour is owing, but sometimes the pigment is not contained within cells; under this is a thick layer, forming the greater part of the substance of the integument, impregnated with calcareous salts, and frequently furnished with direct prolongations in the form of tubercles, spinous appendages, or hairs. See Shell. The innermost layer consists of a delicate fibrous coat, corresponding to an internal periosteum or true skin; it plays an important part in the moulting process (*ecdysis*) which the Crustacea undergo, probably secreting the new layers of the integument.

The higher Crustacea (the Decapoda) have mostly two pairs of antennæ.

The oral organs consist of a transverse labrum or upper lip, beneath which is a pair of powerful toothed mandibles, acting laterally, and furnished with palpi. Next come two pairs of maxillæ; the first are membranous and hairy at the margin, but without palpi; the second are also membranous and hairy, and correspond to the labium of Insects. Between the mandibles and the first pair of maxillæ is sometimes situated a soft, tongue-like, sometimes cleft appendage. The oral organs undergo various modifications in the lower Crustacea; these will be considered under the respective heads. Behind these are three pairs of secondary or auxiliary jaws, or rather legs converted into jaws, and comparable to the six legs of Insects; these are furnished externally with palpi. Next follow five pairs of true thoracic legs, behind which are five pairs of false or abdominal legs.

The voluntary *muscles* of the Crustacea are transversely striated.

The *eyes* are either simple: consisting of a convex cornea, behind which is a rounded refracting body or lens; this lies in a cup-shaped mass of pigment, perforated by the optic nerves;—compound without facets: consisting of a smooth cornea, behind which a number of closely-placed eyes are situated; sometimes a modification of this form occurs, in the existence of a smooth outer and an inner faceted cornea;—or compound faceted: as in the eyes of insects. The facets are frequently four-sided, but sometimes six-sided. In some of the eyes a conical vitreous body is situated behind the lens. The eyes are sometimes sessile, at others stalked.

The *alimentary canal* is usually short and nearly straight, sometimes curved or coiled. Its wall consists of three or four layers,—the outermost, more or less fibrous, representing a peritoneal coat; the innermost, a transparent, structureless, epithelial coat, furnished at the part corresponding to the stomach with calcareous teeth, scales, or hairs, and which is thrown off during the ecdysis. Between these two coats is a layer of smooth muscular fibres.

The *liver* exists either in the form of simple follicles surrounding the alimentary canal; of branched cæca situated at its upper end, sometimes with short ducts; or as two glandular tufts or branches, consisting of more or less ramified and closely-connected cæca, with short ducts.

In many of the Crustacea the walls of the alimentary canal are surrounded by cells containing a bright orange-yellow or blue fatty matter; these are either scattered or arranged in the form of lobules. They correspond to the fatty body of Insects.

The Crustacea undergo remarkable metamorphoses, the adult form frequently differing strikingly from that of the embryo.

See Asellus, Cirripedia, Entomostraca, Gammarus, Oniscus, and Siphonostoma.

Bibl. That of Animal Kingdom, and the Bibl. of the articles just cited; Gegenbaur, *Vergl. Anat.* p. 470; Schultze (*eyes*), *Qu. Mic. Jn.* 1868, p. 173.

CRYPHÆA, Mohr. = PILOTRICHUM.

CRYPTOCO'CCEÆ.—One of Kützing's families of Algæ, including his genera *Cryptococcus*, *Ulvina*, and *Sphærotilus*, all of which appear to be forms of the mycelia (conidia?) of Mildew Fungi; they consist of masses of extremely minute colourless globules, aggregated into a mucous stratum, and found floating in aromatic waters, vinegar, &c.

CRYPTOCOC'CUS, Kütz. See CRYPTOCOCCEÆ.

CRYPTOGA'MIA.—This term was applied by Linnæus to his 24th Class, which included all plants in which no true flowers exist; the name signifying that the sexual organs are hidden. In Natural Arrangements of the Vegetable Kingdom the term is often used in the same sense, but in this case as one of two great divisions, being opposed to Phanerogamia or Phænogamia, which are plants with the sexual organs conspicuous. See VEGETABLE KINGDOM.

CRYPTOGLE'NA, Ehr.—A genus of Infusoria, of the family Cryptomonadina.

Char. A red eye-spot; carapace a scutellum, rolled in at the margins, without a neck. Aquatic.

C. conica (Pl. 23. fig. 35 *a*). Conical, expanded, and truncate in front, posteriorly subacute; bluish green; length 1-1150''. Two flagelliform filaments.

C. pigra (Pl. 23. fig. 25 *b*). Ovato-subglobose, emarginate in front; green; length 1-1150''. Motion slow; no cilia distinguished.

C. cærulescens. Elliptic, depressed, emarginate in front; bluish green; length 1-6000''. Motion rapid; no cilia distinguished.

Carter adds 3 species.

These organisms require further examination.

BIBL. Ehr. *Infus.* p. 46; Duj. *Infus.* p. 333; Carter, *Ann. N. H.* 1858, ii. p. 253; 1859, iii. p. 18; Pritchard, *Infus.* p. 509.

CRYPTOGRAM'MA = ALLOSORUS.

CRYPTOMONADI'NA, Ehr.—A family of Infusoria.

Char. An envelope or carapace, either soft or hard; no appendages (organs of motion, D.) except anterior cilia, or one or more flagelliform filaments; form constant. (Envelope insoluble in potash?)

These organisms do not admit colouring-matters, hence they should probably be referred to the Algæ. One or more cilia or flagelliform filaments have been detected in all the genera but one (*Lagenella*).

The family corresponds very nearly with the Thecamonadina of Dujardin.

No eye-spot.
Carapace with a distinct tooth in front ... *Prorocentrum.*
Carapace without a tooth ... *Cryptomonas.*

Eye-spot present.
Carapace with a neck ... *Lagenella.*
Carapace without a neck:—
Carapace a scutellum ... *Cryptoglena.*
Carapace not a scutellum ... *Trachelomonas.*

Dujardin adds the genera *Phacus*, D. (including *Euglena*, E. in part), *Crumenula*, D., *Diselmis*, D., *Chlamidomonas*, E., *Plœotia*, D., *Anisonema*, D. (including *Bodo grandis*, E., and *Oxyrrhis*, D. = *Prorocentrum*? E.); and appends doubtfully *Chætoglena*, E., and *Chætotyphla*, E.

See THECAMONADINA, OPHIDOMONAS, and PROTOCOCCUS.

BIBL. Ehrenb. *Infus.* p. 38; Duj. *Infus.* p. 323.

CRYPTOMONAS, E.—A genus of Infusoria, of the family Cryptomonadina.

Char. No eye-spot; carapace without an anterior tooth. Dujardin says: Globular or slightly depressed; secreting a membranous flexible carapace, and furnished with a very delicate flagelliform filament.

The species are not well characterized. Ehrenberg admits seven, and to these Dujardin adds two.

C. ovata, E. (Pl. 23. fig. 36 *a*); length 1-570''; aquatic.

C. lenticularis, E. (Pl. 23. fig. 36 *b*); length 1-1730''; aquatic.

C. fusca, E. (Pl. 23. fig. 36 *c*); length 1-1500''; aquatic.

C. globulus, D. (Pl. 23. fig. 36 *d*); length 1-2500''; aquatic.

C. inæqualis, D. (Pl. 23. fig. 36 *e*); length 1-2500''; marine.

Dujardin appends *Cryptoglena*, E., and *Lagenella*, E. to this genus.

BIBL. Ehr. *Infus.* p. 40; Dujardin, *Infus.* p. 329.

CRYPTONEMIA'CEÆ.—A family of Florideæ. Purplish or rose-red sea-weeds, with a filiform or (rarely) expanded, gelatinous or cartilaginous frond, composed wholly or in part of cylindrical cells connected together into filaments. Axis formed of vertical, periphery of horizontal radiating filaments. FRUCTIFICATION:—1. *Conceptacles* (*favellidia*), globose masses of spores immersed in the frond or in swellings of the branches. 2. *Tetraspores* variously dispersed. 3. *Antheridia* (*Nemaleon*).

Subtribe 1. COCCOCARPEÆ. *Frond solid*,

dense, cartilaginous or horny. Favellidia contained in semi-external tubercles or swellings of the frond.

1. *Grateloupia. Frond* pinnate, flat, narrow, membranaceo-cartilaginous, of very dense texture. *Favellidia* immersed in the branches, communicating with the surface by a pore. *Tetraspores* scattered.

2. *Gelidium. Frond* pinnate, compressed, narrow, horny, of very dense structure. *Favellidia* immersed in swollen ramuli. *Tetraspores* forming subdefined sori in the ramuli.

3. *Gigartina. Frond* cartilaginous, cylindrical or compressed, its flesh composed of anastomosing filaments, lying apart in firm gelatine. *Favellidia* contained within external tubercles. *Tetraspores* massed together in dense sori, sunk in the frond.

Subtribe 2. SPONGIOCARPEÆ. *Frond solid, dense, cartilaginous or horny. Favellidia of several imperfectly known. Wart-like swellings composed of filaments, sometimes containing tetraspores, sometimes spores.*

4. *Chondrus. Frond* fan-shaped, dichotomously cleft, cartilaginous, of very dense texture. *Tetraspores* collected into sori, immersed in the substance of the frond.

5. *Phyllophora. Frond* stalked, rigid, membranaceous, proliferous from the disk, of very dense structure. *Tetraspores* in distinct superficial sori or in special leaflet-like lobes.

6. *Peyssonelia. Frond* depressed, expanded, rooting by the under surface, concentrically zoned, membranous or leathery. *Tetraspores* contained in superficial warts.

7. *Gymnogongrus. Frond* filiform, dichotomous, horny, of very dense structure. *Tetraspores* strung together, contained in superficial wart-like sori.

8. *Polyides. Root* scutate. *Frond* cylindrical, dichotomous, cartilaginous. *Favellæ* contained in spongy external warts. *Tetraspores* scattered through the peripheric stratum of the frond, cruciate.

9. *Furcellaria. Root* branching. *Frond* cylindrical, dichotomous, cartilaginous. *Favellæ* unknown. *Tetraspores* deeply imbedded among the filaments of the periphery, in the swollen pod-like upper branches of the frond, transversely zoned.

Subtribe 3. GASTROCARPEÆ. *Frond gelatinously membranaceous or fleshy, often of lax structure internally. Favellidia immersed in the central substance of the frond, very numerous.*

10. *Dumontia. Frond* cylindrical, tubular, membranaceous. Tufts of *spores* attached to the wall of the tube inside.

11. *Halymenia. Frond* compressed or flat, gelatinoso-membranaceous, the membranous surfaces separated by a few slender anastomosing filaments. Masses of *spores* attached to the inner face of the membranous wall.

12. *Ginannia. Frond* cylindrical, dichotomous, traversed by a fibrous axis; the walls membranaceous. Masses of *spores* attached to the inner face of the membranous wall.

13. *Kallymenia. Frond* expanded, leaf-like, fleshy-membranous, solid, of dense structure. *Favellidia* like pimples, half immersed in the frond, and scattered over its surface.

14. *Iridæa. Frond* expanded, leaf-like, thick, fleshy-leathery, solid, of dense structure. *Favellidia* wholly immersed, densely crowded.

15. *Catenella. Frond* filiform, branched, constricted at intervals into oblong articulations; the tube filled with lax filaments.

Subtribe 4. GLOIOCLADIEÆ. *Frond loosely gelatinous, the filaments of which it is composed lying apart from one another, surrounded by a copious gelatine. Favellidia immersed among the filaments of the periphery.*

16. *Cruoria. Frond* crustaceous, skin-like.

17. *Naccaria. Frond* filiform, solid, cellular; the ramuli only composed of radiating free filaments.

18. *Gloiosiphonia. Frond* tubular, hollow; the walls of the tube composed of radiating filaments.

19. *Nemaleon. Frond* filiform, solid, elastic, filamentous; the axis composed of closely-packed filaments; the periphery of moniliform free filaments.

20. *Dudresnaia. Frond* filiform, solid, gelatinous, filamentous; the axis composed of a network of anastomosing filaments; the periphery of moniliform free filaments.

21. *Crouania. Frond* filiform, consisting of a jointed filament, whorled at the joints, with minute, multifid, gelatinous ramuli.

BIBL. Harvey, *Marine Algæ*; Derbés et Solier, *Ann. des Sc. Nat.* 3 sér. xiv. 273. See also the Genera.

CRYPTOSPO'RIUM, Kze.—A genus of Sphæronemei (Coniomycetous Fungi). Microscopic Fungi growing upon bark and leaves, producing spindle-shaped spores, at first conglutinated beneath the epidermis of

the nurse-plant. Two species have been recorded as British.

1. *C. Caricis*, Corda. Heaps of spores punctiform; spores slightly curved, dark brown and pellucid. On leaves of various sedges. Corda, *apud* Sturm, *Deutschl. Flor.* t. 1.

2. *C. vulgare*, Fries. Heaps confluent; spores curved, black (subhyaline). On dead twigs of birch, hazel, alder, &c. Corda, *l. c.* t. li.

Bibl. Berkeley and Broome, *Ann. of Nat. Hist.* 2 ser. v. p. 371; Fries, *Syst. Myc.* iii. p. 481.

CRYPTOSTE'GIA, Reuss.—A group of hyaline Foraminifera, having an Agathistegian or Milioline mode of growth, comprising *Chilostomella* and *Allomorphina*, Reuss. These are probably allies of *Sphæroidina*, and thereby related to *Pullenia* and *Globigerina*. *Chilostomella* has successive chambers, almost entirely overlapping one another, as in *Biloculina*; but with a hyaline, and not a porcellaneous shell.

Recognized only in Cretaceous and Tertiary strata; but probably to be found among recent forms grouped as *Miliolæ*.

Bibl. Reuss, *Syst. Zusam. For.* in *Sitzungs. Akad. Wien*, 1861, xliv. 372.

CRYSTALLINE LENS. See Eye.

CRYSTALLOG'RAPHY.—The laws of crystallography teach us that in perfectly formed crystals, each peculiar chemical combination corresponds to a distinct relation of all the angles which can possibly arise from the primary form; hence by ascertaining the latter, we can usually infer the former. It was our intention to have given a sketch of the method of determining the primary forms of the more common microscopic crystals, and the systems to which they belong; but our space is far too limited for this purpose, and the subject is so difficult, that we must rest satisfied with a reference to works specially devoted to the subject.

Bibl. Schmidt, *Entw. ein. allg. Untersuch. &c.*; Robin and Verdeil, *Traité de Chimie Anatom. &c.*; Phillips, *Elem. Introduct. to Mineral.* (Brooke and Miller); Dana, *Syst. of Mineral.*; Naumann, *Element. d. Mineral.*; Nicol, *Man. of Mineralogy*; Rammelsberg, *Lehrb. d. Krystallkunde.*

CRYSTALLOIDS.—These bodies have been noticed under Chalk and Coccoliths.

CRYSTALS.—Crystals are constantly met with in the examination of animal and vegetable products; and the determination of their nature or composition is often of great importance.

There are four methods of determining this: 1, by ascertaining the atomic weight of the substance, or by its quantitative analysis; 2, by the study of its crystallographic properties; 3, by its qualitative analysis; 4, by its spectroscopic analysis.

The first belongs to the domain of chemistry, and requires an appreciable quantity of substance.

The second requires well-formed crystals, and a knowledge of crystallography. As the latter is an exceedingly difficult science, recourse is generally had to the third method, upon which some remarks have already been made in the Introduction, p. xxxviii; the fourth is indispensable in many cases, but requires expensive apparatus and great practice.

The forms of crystals vary according to the conditions under which they are produced; but there can be no doubt that under absolutely the same conditions, their forms would be relatively constant. In many animal and other liquids, the forms assumed by the crystals deposited are tolerably characteristic, so that their composition may be inferred; but where accuracy is required, it is always well to use chemical reagents. See Raphides.

The cavities in topaz and other mineral crystals were shown years ago by Brewster to enclose a liquid, crystals, or even a vacuum. This subject has been further investigated by Sorby in rocks, stones, lava, &c., who has deduced important geological conclusions therefrom. The same observer has also drawn attention to the cavities containing air or vapour in artificial crystals, and to the crystals formed in blowpipe beads.

Crystals, when rapidly formed, constitute beautiful microscopic objects; the arborescent, radiating and other appearances which they present are well known; and a more exquisitely curious and interesting sight cannot be witnessed than the very formation itself taking place under the microscope. This may be readily seen in a drop of any saline solution spontaneously evaporating upon a slide. See Uric acid and Polarization; and for crystals in plants, Raphides.

Bibl. See Chemistry and Crystallography; also Sorby, *Geol. Jn.* xviii.; id. (*blowpipe beads*) *Month. Mic. Jn.* i. 349;

Davies, *Qu. M. Jn.* 1864, 247, 1865, 205; Guy, *Mic. Trans.* 1868, 1.

CTENOSTO'MATA.—A suborder of Infundibulate Polyzoa (Bryozoa). Distinguished by the cell-orifice being surrounded by a fringe of bristles (more or less developed) when the animal is protruded. Three families:

1. *Alcyonidiadæ.* Polypidom sponge-like, fleshy, irregular in shape; cells immersed, with a contractile orifice.

2. *Vesiculariadæ.* Polypidom plant-like, horny, tubular; cells free, deciduous, the ends flexible and invertible.

3. *Pedicellinidæ.* Polypidom plant-like, creeping, adherent, sending up at irregular intervals free, erect, stalked polypes, without distinct cells.

Bibl. Johnston, *Brit. Zooph.*; Gosse, *Mar. Zool.* ii.

CUCULLA'NUS, Müll.—A genus of Entozoa, belonging to the order Cœlelmintha, and family Nematoidea.

Char. Body elongate, posteriorly attenuate; head broad, with a bivalve manducatory apparatus; mouth anterior, terminal, forming a long vertical fissure.

C. elegans. Found in the intestine, stomach, and pyloric appendages of the perch and other freshwater fishes. Almost all the other species of this genus live also in the intestines of fishes. Length 1-6 to 1-3″. Colour, reddish yellow.

Bibl. Dujardin, *Helminthes,* p. 245.

CUCURBITA'RIA, Grev. See Sphæria.

CU'LEX, Linn.—A genus of Dipterous Insects, of the family Culicidæ.

Char. Palpi longer than the proboscis in the male, very short in the female.

Many species. *C. pipiens,* the common gnat. See Culicidæ.

CULIC'IDÆ.—A family of Dipterous Insects, as the type of which the common gnat (*Culex pipiens*) may be examined.

The parts of the mouth are produced into a slender elongated rostrum or proboscis, which is nearly half the entire length of the insect, and slightly thickened at the tip. This proboscis, simple as it appears, in reality consists of seven pieces in the females, besides a pair of many-jointed palpi, which are as long as, or even longer than, the rostrum in some of the males, and very hairy at the extremity; in the females, however, they are generally very short. Head small. Antennæ slender and filiform, as long as, or longer than the thorax, and 14-jointed in both sexes; but they are plumose in the males (Pl. 26. fig. 21) and pilose in the females (Pl. 26. fig. 30 *a*); the basal joint is subglobose and tubercular in form. Eyes lunate; ocelli obsolete. Thorax oblong-oval. Abdomen long and slender, upon which the wings are incumbent when at rest; the latter have the veins furnished with scales (Pl. 27. fig. 22). Legs very long and slender.

The proboscis of the female is composed of the following parts:—1. An outer tubular canal (Pl. 26. figs. 30 & 31 *e*), representing the labrum, forming the most robust part of the mouth, except the labium. 2. A pair of slender, needle-like pieces, the mandibles, serrated on the inside near the tip (Pl. 26. figs. 30 & 31 *f*), thickened at the back, like a scythe, and transversely striated. 3. A second pair of very delicate and slender organs (Pl. 26. figs. 30 & 31 *g*), dilated at the base, to which the palpi are attached, representing the maxillæ. 4. A slender, needle-like instrument, lanceolate at the end, traversed by a narrow canal (Pl. 26. figs. 30 & 31 *d*), the analogue of the tongue. 5. The outer tubular canal (Pl. 26. fig. 30 *i*), in which the others are lodged when at rest, and representing the labium. The labrum and labium are each traversed by a longitudinal slit throughout their length.

It appears that in the males the labrum and tongue are absent. It has been supposed that, when the lancets of the female gnat are introduced into the skin, a venomous liquid is simultaneously instilled into the wound, and that the great irritation produced may thus be accounted for. It is more probable, however, that this arises from the deeper penetration of the lancets into the skin; for they are of great comparative length—about four times that of the lancets of the flea.

The eggs are deposited in a small boat-shaped mass, which floats upon the surface of the water. They are oval, with a small narrow knot at the top, and are arranged side by side, and closely packed.

The larvæ inhabit standing waters, and may be observed frequently, during the spring and summer, jerking themselves about with great agility, or suspending themselves, for the purpose of respiration, immediately below the surface of the water, with the head downwards. The head (Pl. 28. fig. 1) is distinct, large, rounded, and furnished with two unjointed antennæ, and several ciliated appendages, which serve for

obtaining nourishment. The thorax is furnished with bundles of feathery hairs; the abdomen is long, nearly cylindrical, much narrower than the front parts of the body, and divided into ten segments, the eighth of which is furnished with a long respiratory air-tube, terminated by a small star; the last joint is terminated by setæ, and by five conical slender plates.

After several moultings, the larvæ are transformed into pupæ, which also move about with agility by means of the tail and two terminal swimming organs. In this state they take no food; and the position in which they suspend themselves in the water is the reverse of that previously assumed, *i. e.* the head is upwards. The respiratory organs consist of two air-tubes placed upon the thorax; and the body is much curved. The final transformation takes place in three or four weeks, the exuviæ of the pupa serving as a raft, upon which the insect remains until its wings are extended.

BIBL. Westwood, *Introd. &c.* p. 507; Robineau Desvoidy, *Mém. Soc. d'Hist. Nat.* iii. 1827, p. 390; Stephens, *Zool. Jn.* i.; Curtis, *Brit. Entom.* xii. 537; Macquardt, *Dipt.* (*Suites à Buff.*); Walker, *Insect. Brit. Dipt.* iii. p. 242.

CUNEOLINA, D'Orb.—A Textilarian Foraminifer, extremely compressed transversely to the usual direction of the compression in *Textilaria.*

Rare in the Lower Cretaceous formation.

BIBL. D'Orbigny, *For. Foss. Vien.* 1846; Carpenter, *Introd. For.* 193.

CUPRESSIN'EÆ.—A suborder of Coniferæ (Gymnospermous Flowering Plants), distinguished from the Abietineæ by the erect ovules and spheroidal pollen-grains. Further particulars will be found under CONIFERÆ and WOOD.

CURCU'LIO, Linn.—A genus of Coleopterous Insects of the family Curculionidæ (weevils).

Curculio imperialis, the diamond-beetle, is well known on account of the splendid colours which it exhibits. Many other members of this family present colours almost equally brilliant. These colours are produced mainly by the action of minute scales upon the incident light. See SCALES OF INSECTS.

The oral organs of the Curculionidæ are curiously placed at the end of an elongated rostrum which represents the head, and to the sides of which the antennæ are attached.

BIBL. Westwood, *Introd. &c.*; Stephens, *British Beetles.*

CURCU'MA, L.—A genus of Zingiberaceæ (Monocotyledons), remarkable on account of the tuberous rhizomes. Those of *C. longa* form the substance called turmeric; and the starch from the cells of the young tubers forms one of the kinds of East-Indian arrow-root. The tubers of other species yield very pure starch, and furnish East-Indian arrow-roots. The grains of an unknown *Curcuma* imported under that name are represented in fig. 19 of Plate 36.

CUS'CUTA, Tournefort.—A curious genus of Convolvulaceæ (Dicotyledons), consisting of parasitical, leafless plants, annual or perennial, nourished by short radical processes, which they usually send into the interior of the stems of the plants upon which they live, although they sometimes affix themselves to leaves also (*C. Epithymum*). *C. Epilinum*, which grows in cultivated fields of flax, and *C. Trifolii*, parasitical on clover, twine round the stems like a fine red string, and produce root-processes in rows on the side next the nurse-plant, never on the free side. Careful sections show that the woody structure of the roots of the parasite penetrates the cambium (or even the pith) of the nurse-plant, and becomes completely grafted on it. In the perennial kinds (*C. verrucosa*), the roots become imbedded in the annual rings. The embryo of *Cuscuta* is curious, being filiform, and coiled up like a watch-spring in the seed.

BIBL. Wheeler, *Phytologist*, i. 753; Brandt, *Linnæa*, xxii. 81 (1849); Schacht, *Beiträge z. Anat. und Phys.* 1854, p. 167.

CUSPIDEL'LA, Hincks.—A genus of Hydroid Polypi; family Lafoëidæ.

C. humilis. Wales, Shetland, Northumberland.

BIBL. Hincks, *Brit. Zooph.* p. 209.

CUTICLE OF ANIMALS. See SKIN.

CUTICLE OF PLANTS. See EPIDERMIS.

CUTLE'RIA.—A genus of Cutleriaceæ (Fucoid Algæ), represented in Britain by *C. multifida*, which has a "rooting," fan-shaped, irregularly laciniated frond from 2 to 8″ long, the laciniæ riband-like, between cartilaginous and membranous, olive, with scattered sori, bearing on some plants (which have an orange tint) *antheridia*, and in others *oosporanges* (fig. 148).

The oosporanges (fig. 148) occur at the bases of tufted hairs, and are oblong stalked

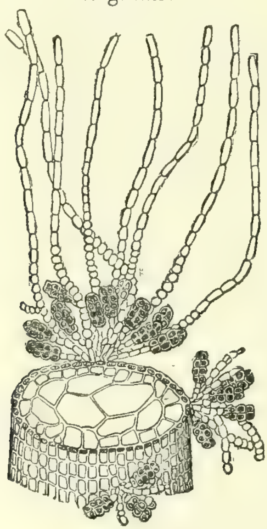
bodies, divided by perpendicular and transverse septa into (usually) 8 chambers, each of which gives birth to a zoospore capable of germination. The *antheridia* occur in an analogous condition on distinct plants; they are more sausage-shaped, and divided into a greater number of minute chambers, from which the spermatozoids or antherozoids are expelled when mature; these have never been seen to germinate.

Fig. 148.

Cutleria dichotoma.
Fragment of a frond.
Nat. size.

BBL. Harvey, *Brit. Mar. Alg.* 36, pl. 6 A; *Phyc. Brit.* pl. 75; Greville, *Brit. Alg.* pl. 10; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. 241, pl. 31, xvi. 12, pl. 1; Kützing, *Phyc. gen.* pl. 25. fig. 2.

Fig. 149.



Cutleria dichotoma.
Fig. 149. Section of a lacinia of a frond, showing the stalked eight-chambered oosporanges growing in tufts with intercalated hairs. Magnified 50 diameters.

CUTLERIA'CEÆ.—A family of Fucoid Algæ. See CUTLERIA.

CUTTLE-FISH. See SEPIA.

CYATHÆ'EÆ.—A tribe of Polypodiaceous Ferns, distinguished by the insertion of the sporanges on a projecting axis, the annulus of the sporanges being vertical (fig. 151).

Genera.

A. *Sori without indusia.*

1. *Alsophila.* Sori globose, regularly arranged. Sporanges inserted on a globose axis, and imbricated.
2. *Trichopteris.* Sori globose, regularly arranged, laterally confluent. Sporanges on a globose axis, areolate and crinite with long hairs.
3. *Metaxya.* Sori globose, each fertile vein bearing several sori, irregularly scattered. Sporangia inserted on a globose axis, beset with long articulated hairs.

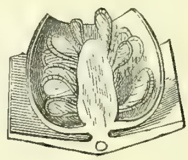
B. *Sori indusiate.*

4. *Hemitelia.* Sorus globose, each solitary on a pinnule. Indusium an ovate, concave, torn scale, situated at the lower side of the base.
5. *Cnemidaria.* Sori globose, regularly arranged. Indusium forming an involucre, at length irregularly torn or partite.
6. *Cyathea.* Sori hemispherical, regularly arranged. Indusium at first closed, at length bursting in a circumscissile manner, and cup-shaped.
7. *Schizocæna.* Sori regularly arranged, the indusium consisting of six lobes surrounding the globose receptacle.

CYA'THEA, Smith.—A genus of Cyathææ (Polypodiaceous Ferns), many of which are arborescent. They have a cup-like indusium, whence the name. Exotic (figs. 150, 151).

Fig. 150.

Fig. 151.



Cyathea elegans.
Fig. 150. Pinnule with sori. Magnified 5 diameters.
Fig. 151. Vertical section of a sorus in a cup-like indusium. Magnified 25 diameters.

CY'ATHUS, Hall. See NIDULARIACEI.

CYCADA'CEÆ.—A family of Gymnospermous Flowering Plants. The microscopic structure of the wood is analogous to that of the Conifers, and the mode of fertilization of the ovules is similar. (See GYMNOSPERMIA.) Species of *Cycas*, *Zamia*, &c. are commonly cultivated in botanical gardens. They offer interesting subjects of microscopic investigation. The parenchymatous tissue, in the form of pith, large medullary rays, and in *Cycas* of concentric rings alternating with those of the wood, is remarkable for the quantity of starch contained in it at certain periods. This is extracted and used as arrowroot or sago. *Cycas circinalis* furnishes a kind of sago (its starch-grains are represented in fig. 17. Pl. 36). *Dion edule* yields a kind of arrow-root in Mexico. *Encephalartos* yields Caffre-bread at the Cape, &c. The wood is composed, in *Cycas* and *Zamia*, almost wholly of large dotted tubes, somewhat like those of *Araucaria* (with many rows of bordered pits) (Pl. 39. fig. 20); but a medullary sheath exists, composed of unrollable spiral vessels, with tubes of varied character, reticulate, annular or other fibrous forms, as in the Dicotyledons; and in *Zamia* the dotted tubes are said to be unrollable in some cases into spiral ribands. In *Zamia* and *Encephalartos* there does not appear to be a distinction of concentric rings of wood; but in *Cycas* these exist, separated by layers of cellular tissue. The rings, however, are not "annual," only five or six existing in large old trunks. The leaves of the Cycadaceæ possess a remarkably solid epidermal structure; and in *Cycas* the upper thickened walls of the epidermal cells exhibit pore-canals or deep pits running from the cavity of the cell toward the outer surface, as well as towards the contiguous cells (Pl. 38. fig. 28). See EPIDERMIS. The pollen of the Cycadaceæ is angular, collected in masses and transparent; it is contained in anthers of peculiar form seated on the lower surface of the scales of the male cones.

BIBL. Don, *Ann. Nat. Hist.* v. 48; *Linn. Trans.* xvii.; Brongniart, *Ann. d. Sc. Nat.* xvi. 589; Mohl, *Verm. Schrift.* 195; Link, *Icon. Select.* fasc. ii. t. ix. & xv.; Miquel, *Linnæa*, xviii. 125, and pls. 4, 5, 6 (*Ann. des Sc. Nat.* 3 sér. v. 11). Also the works referred to under GYMNOSPERMIA.

CY'CAS, L. See CYCADACEÆ.

CYCLIDI'NA, Ehr.—A family of Infusoria.

Char. No carapace; a single alimentary orifice; appendages in the form of cilia or bristles.

Body with	cilia...	Flattened, cilia forming a circle............	*Cyclidium.*
		Rounded, cilia scattered	*Pantotrichum.*
	bristles		*Chætomonas.*

BIBL. Ehr. *Infus.* p. 244.

CYCLID'IUM, Hill, Ehr.—A genus of Infusoria, fam. Cyclidina (Colpodina, Cl.).

Char. Body compressed; organs of locomotion a circle of abdominal cilia-like feet.

C. glaucoma (Pl. 23. fig. 37 *c*, side view; *d*, dorsal view). Oblong-elliptical, entire, with a long saltatory seta in front; circle of cilia large; dorsal lines very fine; contractile vesicle placed at the front end; aquatic; length 1-2880 to 1-1150''. Cl. & L. include under this species *Acomia ovulum, Alyscum saltans, Enchelys triquetra,* and *Uronema marina.*

C. margaritaceum. Orbicular-elliptic, slightly emarginate posteriorly; cilia obsolete; pearly; aquatic; length 1-2100 to 1-1000'' (this is *Glaucoma margaritaceum*, Clap. & Lachm.).

Two doubtful species,—*C. planum* and *lentiforme.*

C. elongatum, Cl. & L.

Dujardin includes his species of *Cyclidium*, the relation of which to those of Ehrenberg is doubtful, in the family Monadina, with the characters—

Body disk-shaped, depressed or lamelliform, but little variable in form, with a single flagelliform filament. Four species:

1. *C. nodulosum.* With series of nodules and vacuoles; motion extremely slow; aquatic; length 1-530''.

2. *C. abscissum* (Pl. 23. fig. 37 *b*). Lamelliform, oval, truncated posteriorly; motion slow; aquatic; length 1-920''.

3. *C. distortum* (Pl. 23. fig. 37 *a*). Oval, nodular, irregularly twisted; margin thickened; aquatic; length 1-1800''.

4. *C. crassum.* Aquatic; length 1-1800 to 1-1100''.

BIBL. Ehr. *Infus.* p. 245; Duj. *Infus.* p. 286; Cl. & L. *Inf.* p. 271.

CYCLOCLY'PEUS, Carpenter.—A relatively large, discoidal, Nummuline Foraminifer, which grows by concentric *annuli* of chamberlets, instead of spirally with successive chambers. It thus bears the same relation to its ally *Heterostegina* that *Orbitolites* does to *Orbiculina.* Known only recent from Borneo.

BIBL. Carpenter, *Phil. Trans.* 1856; *Introd. For.* 292.

CYCLOGLE'NA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes more than three, forming a cervical group; foot forked.

Pharyngeal jaws with one or perhaps three teeth!

C. lupus (Pl. 34. fig. 18). Body ovate-oblong or conical, not auricled; foot and toes short; aquatic; length 1-144 to 1-120″.

C.? elegans. In Egypt.

BIBL. Ehr. *Infus.* p. 453.

CYCLOGRAM'MA, Perty.—A genus of Infusoria.

C. rubens = a *Nassula*, Cl. & L.

BIBL. Clap. & Lachm. *Infus.* p. 326; Perty, *Lebensf.* p. 146.

CYCLOLI'NA, D'Orb.—An excessively thin discoidal condition of *Patellina*, consisting of perfect *annuli* and very little umbilical cell-growth. In Cretaceous strata, France. Carter's *Cyclolina* is equivalent to *Orbitolites.*

BIBL. D'Orb. *For. Fos. Vien.* 139; Parker and Jones, *Ann. N. H.* ser. 3. vi. 36; Carpenter, *Introd. For.* 230, 233.

CY'CLOPS, Müller.—A genus of Entomostraca, of the order Copepoda, and family Cyclopidæ.

Charact. Foot-jaws large and strong, branched; eye single, frontal; inferior antennæ simple; external ovaries two. (Both superior antennæ in the male furnished with the swelling and hinge-joint.)

C. quadricornis (Pl. 15. figs. 8–15). The only species. Variable in colour; aquatic; length 1-17 to 1-14″.

Char. Those of the genus.

Thorax composed of four, and abdomen (apparently the tail) of six segments; head consolidated with the first and largest joint of the thorax; last joint of abdomen consisting of two separate lobes.

Superior antennæ (figs. 8, 9 *a*) composed of many joints (twenty-six, Baird), from each of which one or more setæ arise; in the male, each superior antenna exhibits a swelling at about its middle (fig. 8 *b*) followed by a sudden contraction, the first articulation of which forms a hinge-joint; inferior antennæ (fig. 9*b*) four-jointed, each joint with setæ, the terminal with six of unequal length. The mandibles (fig. 11) consist of an ovate body (*a*), narrowed and twisted above, and terminating in a number of brownish teeth, with a marginal serrated seta (*b*); each mandible has also a palpus, consisting of one segment and two long filaments.

Behind the mandibles, the first pair of foot-jaws (fig. 12) are situated; each consists of a body, convex externally, concave internally, furnished at the end with two or three strong teeth, and with a single-jointed palp-like organ terminated by setæ.

The second pair of foot-jaws (fig. 13 *a b*) are divided to the base into two portions: an internal (*b*) smaller, and consisting of four joints, each with one or more setigerous spines, the last with three; and an external (*a*) composed of three joints, to the base of the first of which the internal portion is attached; this first joint is the longest, and furnished on its inner side with two tubercles, each with one or two setigerous spines, a longer jointed spine arising from near its distal extremity; the second joint is furnished with two strong claws of nearly equal size; and to its upper edge is attached the third joint, smaller than the second, also furnished with two claws; some of the spines are themselves setigerous.

There are five pairs of legs or feet, four of which are branchial, uniform, and arise from the thoracic segments. Each of these legs (fig. 14) is composed of two branches arising from a common base; each branch is three-jointed, and each joint is furnished with elegantly plumose setæ, the last having six or seven. The fifth pair of legs (fig. 15) are rudimentary, and arise from the first and smallest segment of the abdomen; they are two-jointed in the female, and three-jointed in the male.

The external ovary (fig. 9 *o*) communicates directly with the internal by means of a small canal on each side between the first and second segments of the abdomen.

The tail consists of two lobes, each terminated by four variously setigerous filaments, the two intermediate being the longest, and jointed near their origin; sometimes there are two joints to each, and the outer ones are also jointed.

Scarcely a pool of water can be found in which this animal may not be seen darting about in various directions. It varies greatly in structure and appearance, according to age, locality, sex, &c.; and these varieties have been admitted as so many species by some authors.

Pl. 15. fig. 16 represents a recently hatched *Cyclops.*

The individuals are frequently covered with *Vorticellæ* and other parasitic Infusoria.

Bibl. Baird, *Brit. Entom.* p. 198; Koch, *Deutschl. Crustac.* &c.; Claus, *Wieg. Arch.* 1857, p. 1.

CYCLOSTO'MATA.—A suborder of marine Infundibulate Polyzoa.

Two families: Tubuliporidæ and Crisiadæ.

CYCLOTELLA, Kütz.—A genus of Diatomaceæ.

Char. Frustules free or adherent to other bodies, disk-shaped, mostly solitary; valves circular, flat, convex, depressed or undulated, striated; striæ radiating.

The frustules of some of the species are immersed in an amorphous gelatinous substance.

When the valves of (all?) the species of *Cyclotella* are examined under an object-glass of large aperture, with the central stop (Intr. p. xvi *et seq.*), the surface is found to be marked with dots or depressions arranged in radiating rows, as in some species of *Coscinodiscus*; hence these two genera should probably be united. Some of the species (?) appear to represent the frustules of *Melosira* seen in end view.

C. operculata, K. (*Pyxidicula operculata*, E., *Discoplea Kutzingii*, E.) (Pl. 12. fig. 21; *a*, side view; *b*, front view). Angles of frustules in front view rounded; striæ obscure, very short, giving the margin a punctate appearance; aquatic; diameter attaining 1-1000″.

β. rectangula, K. (*C. Kützingiana*, S.) (Pl. 12. fig. 22). Angles of front view not rounded; striæ more distinct.

C. Meneghiniana. Valves plane, distinctly striated at the margin; aquatic; length 1-1440″.

β. major. Twice as broad.

C. antiqua, S. (*Discoplea atmospherica*, E.). Valves convex; striæ broad, reaching neither the centre nor the margin; aquatic; diam. 1-760″.

Kützing characterizes three marine species, with the valves free from striæ, and seventeen doubtful species, marine and fossil, belonging to the genera *Actinocyclus*, *Discoplea*, and *Hyalodiscus* of Ehrenberg. Rabenhorst describes 9 species.

Bibl. Kützing, *Syn. Diat.*, *Bacill.* p. 50, and *Sp. Alg.* p. 18; Ehrenberg, *Berl. Ber. passim*; id. *Infus.*, and *Mikrog. &c.*; Smith, *Brit. Diat.* p. 27; Thwaites, *Ann. Nat. Hist.* 1848, i. p. 169.

CY'CLOUM, Hass.—A genus of Infundibulate Ctenostomatous Polyzoa.

Char. Polypary fleshy, incrusting, covered with imperforate papillæ; ova in clusters.

C. papillosum. Tentacles 18; on *Fucus serratus*.

Bibl. Hassall, *Ann. Nat. Hist.* 1841, vii. p. 483; Gosse, *Mar. Zool.* ii. p. 19 (fig.).

CYLINDROCYS'TIS. See Coccochloris.

CYLINDROLEBE'RIS, Brady.—A genus of Ostracode Entomostraca, fam. Cypridinidæ.

2 recent British species: *C. mariæ* and *C. teres*, both marine.

Bibl. Brady, *Linn. Trans.* xxvi. p. 464.

CYLINDROSPER'MUM, Kützing (*Anabaina*, Bory and others).—A genus of Nostochaceæ (Confervoid Algæ), with the filaments less radiating than in the allied *Sphærozyga*; distinguished under the microscope by the resemblance of the filaments to an annulose animal, the ordinary cells looking like a long jointed body, the large elliptic sporangial cell like a thorax, and the terminal vesicular cell often bearing fine hairs, like a head. British species:

1. *C. catenatum*, Ralfs (Pl. 5. fig. 4). Filaments moniliform; ordinary cells orbicular; vesicular cells oval; sporanges oval, catenate. (Ralfs, *Ann. Nat. Hist.* ser. 2. vol. v. pl. 9. fig. 14.) Forming a bluish stratum, containing very delicate, elongated, straight or slightly flexuose, generally parallel filaments.

The remaining British species are not described by Mr. Ralfs; but the following are noticed as British by Kützing (*Species Algarum*) under the head of *Cylindrospermum*.

2. *C. macrospermum*, Kützing. Filaments thick, equal; ordinary cells oblong, 1-700th of a line in diameter; sporanges oblong, turgid, firm, fuscous, 1-100 to 1-60‴ long, 1-300 to 1-200‴ thick. Kützing, *Sp. Algarum*, 293; *Tab. Phyc.* vol. i. pl. 98. fig. 4. *Anabaina impalpebralis*, Hassall, *Br. Fr. Algæ*, pl. 75. fig. 3. Standing water; forming an æruginous green stratum.

3. *C. mesoleptum*, Kützing. Filaments densely entangled, unequal, 1-800 to 1-650‴ thick; sporanges oblong, 1-180 to 1-150‴ long, 1-350 to 1-300‴ broad, slightly constricted in the middle. Kützing, *Sp. Alg.*; *Tab. Phyc.* vol. i. pl. 98. fig. 5. *Anabaina constricta*, Hassall, *Br. Fr. Algæ*, pl. 75. fig. 9. Æruginous green; in brackish marshes.

Excluded species of Kützing:—*C. elongatum* = *Sphærozyga elastica*, Ag. (Ralfs); *C. leptospermum* = *Sphærozyga leptosperma* (Ralfs); *C. Carmichaelii* = *Sphærozyga Car-*

michaelii (Harvey); *C. Ralfsii* = *Dolichospermum Ralfsii* (Ralfs); *C. Hassallii*= *Coniophytum Thompsoni* (Hassall).

Rabenhorst describes 13 European species.

Bibl. Ralfs *on Nostochineæ, Ann. of Nat. Hist.* ser. 2. vol. v. p. 321; Kützing, *Sp. Alg.*

CYLINDROS'PORUM, Grev.—A supposed genus of parasitic Fungi, stated by Tulasne to consist of the conidiiferous forms of Sphæriacei.

C. concentricum, Grev. = *Uredo cylindrospora*, Hook. *Br. Fl.*, grows upon the leaves of cabbages. It appears, however, from recently found specimens, that Greville's plant is really a species of *Glœosporium*, and quite different from fungi with which it has been confounded.

Bibl. Grev. *Sc. Crypt. Fl.* t. xxix.; Berkeley, *Hort. Trans.* iii. 265; Tulasne, *Ann. des Sc. Nat.* 4 sér. v. p. 109; Berkeley, *Outl.* p. 325.

CYLINDROTHE'CA, Rab.—A genus of Diatomaceæ.

Char. Frustules fusiform, free, ends acute; with 2 (rarely 1 or 3) longitudinal flexuous costæ; no nodules.

C. Gerstenbergeri (Pl. 42. fig. 34). Living frustules cylindrical, obtusely attenuate at ends; dried frustules fusiform, acuminate; length 1-90″. Common in pools and ditches (Germany).

Bibl. Rabenhorst, *Flor. Alg.* i. p. 145.

CYLINDROTHE'CIUM, Br. and Sch. =Neckera.

Bibl. Wilson, *Bryol. Brit.* p. 326.

CYMATOPLEU'RA, Sm. See Sphinctocystis.

The former name was proposed to designate the genus *Sphinctocystis*, previously founded by Hassall: it cannot, therefore, be retained. See the laws upon the subject of Nomenclature in the *Ann. Nat. Hist.* 1843, xi. p. 259.

Bibl. Smith, *Ann. Nat. Hist.* 1851, vii.

CYMATOSIRA, Grun.—A genus of Diatomaceæ.

Char. Frustules united into bands; undulate in front view; valves lanceolate, distinctly punctate; no median line.

C. Lorenziana (Pl. 42. fig. 34). Valves broadly lanceolate, very convex; ends produced. At the bottom of the Adriatic.

Bibl. Rabenhorst, *Flor. Alg.* i. p. 124.

CYMBALO'PORA, von Hagenow. — One of the Foraminifera Globigerinida, in which the spiral is merged in a cyclical growth at an early stage, the shell increasing by rings of sac-like chambers, which open into the hollow base of the trochoid shell. *C. Poyei* (D'Orb.) (Pl. 47. f. 17) is the type.

Cymbalopora is rare in the Upper Chalk and some Tertiary strata; more common in the tropical seas.

Bibl. Carpenter, *Introd. For.* 215.

CYMBELLA, Ag.—A genus of Diatomaceæ.

Char. Frustules solitary, free; valves cymbiform, unsymmetrical, with a subcentral and two terminal nodules, a submedian longitudinal line, and transverse or slightly radiating striæ. Aquatic and fossil.

Frustules sometimes immersed in an amorphous gelatinous mass.

C. Ehrenbergii, K. (Pl. 13. fig. 31: *a*, front view; *b*, side view). Broadly lanceolate, apices slightly produced, somewhat obtuse; striæ distinct (resolvable into dots); length 1-200″. (Fossil in San Fiore deposit.)

Several British species, and more foreign, differing from each other by slight characters.

Rabenhorst describes 31 European species, with numerous varieties.

Bibl. Smith, *Brit. Diat.* p. 17; Kützing, *Bacill.* p. 79, and *Sp. Alg.* p. 57.

CYMBOSIRA, Kütz.—A genus of Diatomaceæ.

Char. Frustules resembling those of *Achnanthes*; solitary or binate, stipitate, attached end to end, and thus concatenate. Marine.

C. Agardhii (Pl. 14. fig. 18). Frustules linear, slightly arcuate, finely striated, rounded at ends; valves oblong-linear, slightly dilated in the middle, apices obtusely rounded. Length 1-960 to 1-280″. Not British (?).

C. minutula, Grun.

Bibl. Kützing, *Bacill.* p. 77, and *Sp. Alg.* p. 57; Grunow, *Wien. Verh.* 1863.

CYNIP'IDÆ.—A family of Insects, belonging to the Entomophagous section of the order Hymenoptera.

Char. Head small, transverse; antennæ inserted in the middle of the face, of moderate length, slender, not geniculated, composed of twelve to fifteen joints; maxillary palpi of four or five, labial of two or three joints; thorax oval, gibbous, with the mesothorax large, and the scutellum very prominent; wings transparent, with few veins,—the anterior usually with three or four cells, and the posterior with a single vein; abdomen short, much compressed, with a short peduncle, its basal segment

very large, the rest small, forming narrow rings.

In the females of these insects, which are all of small and some of minute size, the last segment of the abdomen, which occupies a considerable portion of its lower surface, forms a channel, in which is lodged the very delicate ovipositor. This organ, the construction of which has been the subject of some controversy, consists, as pointed out by Mr. Westwood, of the same parts as that of the ordinary parasitic Hymenoptera (*Ichneumonidæ*, *Chalcididæ*, &c.), namely, of a superior bristle, channelled beneath, and of two finer inferior bristles, which are received into the channel of the former. Although this ovipositor is not exserted, it is of great length, reaching up to the base of the abdomen in a subspiral curve; it is enclosed at its base between two broad plates, representing the basal joints of the bivalvular sheath of the ovipositor in other Hymenoptera; and the slender second joints of these valves accompany it to the apex of the abdomen. All these parts are concealed within the walls of the abdomen (Pl. 44. fig. 15).

Although placed from their organization in the same section of the Hymenoptera with the parasitic Ichneumonidæ, most of the Cynipidæ feed upon vegetable substances in the larva-state. The females bore with their ovipositor into the tissues of plants and trees, and there deposit their eggs, from which small footless larvæ are produced. The irritation caused by the injury thus done to the tissues, gives rise to a morbid action in the part of the plant attacked, which is thus incited to grow out into an excrescence varying in size, form, and structure according to the specific nature of the plant, the part of the plant upon which, and the parasite by which, the wound has been inflicted. Thus the oak, which, of all our native trees is most infested by Cynipidæ, furnishes nourishment to upwards of a dozen species, which attack all parts of it, from the leaves and flower-buds to the root, and each of which confines its operations to a particular portion of the tree, and gives rise to a peculiar excrescence. These morbid growths are commonly known as *galls*, and the insects producing them as *Gall-flies*; the family, also, is called *Gallicolæ* by some authors. The larvæ feed in the interior of the galls; those of some species are solitary, whilst of others numerous individuals may be found in the same gall, according as the parent insect has deposited one or more eggs in the same spot. When full-grown, the larvæ usually undergo their transformations within the gall; but in some instances they eat their way out, bury themselves in the ground, and there pass to the pupa-state. The larvæ are liable to be attacked by species of parasitic Hymenoptera, especially the long-tailed Chalcididæ (such as *Callimome*, Pl. 44. fig. 14); these pierce through the substance of the gall and deposit their eggs in or upon the Cynipidous larvæ, which are subsequently devoured by those hatched from the eggs of the parasite.

The difference in the nature of the galls produced by these insects does not depend only on that of the plant on which they are produced, as galls of very dissimilar appearance are formed upon the same species of plant, or even on the same leaf, by the puncture of different species of Gall-flies; but the specific cause of this diversity is still unexplained. The tissues of the galls are sometimes soft and juicy, sometimes hard and woody; in the latter case the woody tissue lies immediately beneath the skin, and within it is a layer of cellular tissue filled with starch-grains. These galls are usually formed on branches or twigs. One of the most remarkable of them is the Bedeguar gall of the wild rose, which is produced by the puncture of *Rhodites Rosæ* (Pl. 44. fig. 16): it is a large gall entirely covered with compound bristles, like those of the moss-rose, which give it the appearance of a ball of moss; in its interior are numerous cells, each of which serves as a habitation for a larva; and the whole is produced at the extremity of a shoot of the wild rose, upon which the female gall-fly deposits numerous eggs.

The Cherry-gall of the oak-leaf is produced by *Cynips folii* (fig. 17), one of the commonest of our native species; and another gall-fly, *Teras terminalis* (fig. 18), by attacking the young shoots of the oak gives origin to the well-known oak-apples. The leaves of the oak are also attacked by at least two species of the genus *Neuroterus*, Hartig, the punctures of which give rise to small, flat, rounded galls, attached to the leaf only by a small portion of their lower surface, and bearing so close a resemblance to Fungous plants that they were at one time supposed to be parasitic vegetable growths. These galls, which are commonly known as *oak-spangles*, may be met with in

abundance during the winter on the fallen leaves in oak woods: the flies are produced in the spring; and the most abundant species in this country is the *Neuroterus longipennis* (fig. 19). The root of the oak is attacked by several species, one of which, *Biorhiza aptera* (*Apophyllus*, Hartig), is destitute of wings; and another species deposits its eggs in the male catkins of the same tree, producing a series of galls resembling a small bunch of currants.

It would be impossible for us here to enumerate the different kinds of galls produced by these beautiful little insects even upon our indigenous plants and trees, the history of which in many cases is very imperfect, whilst we have scarcely any information with regard to exotic species. The most important of all is the common gall-nut, which is produced by the puncture of the *Cynips tinctoria* upon the shoots of the *Quercus infectoria*, a species of oak growing in the Levant. The celebrated Dead-sea apples are also found upon this oak; they are as large as a good-sized apple, and of a spongy texture internally, containing only a single larva of a species which has been described by Mr. Westwood under the name of *Cynips insana.*

All the species of Cynipidæ do not, however, produce galls. The species of Hartig's genus *Synergus* deposit their eggs in other galls, upon the substance of which the larvæ, when hatched, feed parasitically, and finally devour the original tenant. Besides these species, which live partly upon vegetable and partly upon animal food, there are many others, forming several genera in Hartig's classification, which live entirely as parasites upon other insects, especially *Aphides* and the larvæ of Dipterous flies, thus justifying the otherwise anomalous position of the Cynipidæ, as a phytophagous family in the Entomophagous group of the Hymenoptera. Amongst these we need only mention the species of the genus *Allotria*, Westw. (*Xystus*, Hartig), of which a very abundant one is parasitic upon the rose-Aphis, and those of the genera *Anacharis, Figites* and *Ibalia.* The latter, of which one species only is known in this country, is remarkable from the structure of its abdomen, which is knife-shaped, and has the segments nearly equal in length; the *Ibalia cultellata* (Pl. 44. fig. 20) is one of the largest British Cynipidæ.

A remarkable circumstance in the history of some of these insects, particularly those of the restricted genus *Cynips*, is that up to the present time none but females have been met with. On the continent and in this country those entomologists who occupy themselves with the study of the Hymenoptera, have bred thousands of gall-flies of different species; but hitherto not a single male of the genus *Cynips* has made its appearance. This circumstance has been adduced by Von Siebold as an example of what he calls "True Parthenogenesis;" and since the appearance of his work on that subject, Mr. F. Smith, of the British Museum, has tested its authenticity in a remarkable manner. A few years since, the attention of entomologists was called to the sudden occurrence of a great abundance of round, hard galls, about the size of a hazel-nut, upon the oaks in Devonshire; these galls were only found in that county. Mr. Smith having procured a large stock of the galls, bred the insects, described under the name of *Cynips lignicola*, in great profusion; but amongst upwards of 250 specimens there was not a single male. He then took several specimens of the females and set them free in the oak-woods at Highgate, to see whether they could really, as was asserted, breed without concourse with the males; and this experiment has perfectly succeeded, as the peculiar galls of this species are now to be met with in several of the woods in the vicinity of Hampstead and Highgate, and it appears even to have extended as far as the neighbourhood of Hendon.

BIBL. Réaumur, *Mémoires*; Burgsdorf, *Schriften der Gesellsch. naturforsch. Freunde*, iv.; Boyer de Fonscolombe, *Ann. des Sc. Nat.* xxvi.; Westwood, *Introd.* vol. ii., *Mag. Nat. Hist.* vi. and viii., and in Guérin's *Mag. de Zoologie*; Walker, *Ent. Mag.* ii. & iii.; Brandt and Ratzeburg, *Medizin. Zool.* ii.; Ratzeburg, *Forst-Insecten*; Bouché, *Naturgesch. d. Insecten*; Hartig in Germar's *Zeitsch. für die Entomol.*

CYNODON'TIUM, Br. and Sch. = DICRANUM.

BIBL. Wilson, *Bryol. Brit.* p. 60.

CYNOPHAL'LUS.—A genus of Phalloidei (Gasteromycetous Fungi), distinguished from *Phallus* by having the pileus imperforate.

C. caninus occurs amongst decayed leaves in woods.

BIBL. Sow. t. 330; Berk. *Outl.* p. 298.

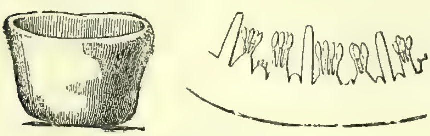
CYNTHIA, Sav.—A genus of Tunicate Mollusca, of the family ASCIDIADÆ.

The numerous species are from $\frac{1}{2}$–2″ in length.

BIBL. That of the family.

CYPHEL'LA, Fries.—A genus of Auricularini (Hymenomycetous Fungi), forming

Fig. 152. Fig. 153.



Cyphella Taxi.

Fig. 152. Entire plant, magnified 10 diameters.
Fig. 153. Horizontal section of the wall of the cup, showing the basidiospores, magnified 250 diameters.

somewhat membranous minute cups, sessile or stalked upon branches of trees or upon mosses; bearing basidiospores on a layer forming a kind of lining to the cup; the spores ultimately separating as a powder in the interior.

Some supposed species of *Peziza*, as *P. villosa* and *P. albo-violascens*, appear to be species of *Cyphella*.

BIBL. Fries, *Syst. Myc.* ii. p. 201; Léveillé, *Ann. des Sc. Nat.* 2 sér. xvi. 237.

CYPHID'IUM, Ehr.—A genus of Infusoria, of the family Arcellina.

Char. Carapace urceolate, tuberculated; expansion variable, broad, single and entire.

The carapace is combustible, and resembles a small cube, with a short pedicle.

C. aureolum (Pl. 23. fig. 38). Cubical, gibbous, expansion (fig. 38 *b*) hyaline; aquatic; length 1-570 to 1-432″.

BIBL. Ehr. *Infus.* p. 135.

CYPHODE'RIA, Schlumb.—A genus of Rhizopoda, of the family Arcellina.

Char. Carapace membranous, resisting, ovoid, elongated in front, recurved and constricted in the form of a neck and marked with oblique rows of projections; orifice circular, oblique; expansions very long, filiform, very slender at the end, simple or branched.

Agrees with *Difflugia enchelys*, E. (*Trinema*, Duj.), in the oblique orifice, the oblique rows of markings, and the nature of the expansions, but differs from it in the presence of the anterior neck-like constriction.

Probably species of *Euglypha* (Cl. & L.).

C. margaritacea. Carapace yellowish, expansions twice its length; aquatic; length 1-380 to 1-180″.

BIBL. Schlumberger, *Ann. des Sc. Nat.* 1845, iii. p. 255.

CYPHONAU'TES, Ehr.—A genus of Rotatoria, of the family Megalotrochæa.

Char. Eyes absent; no teeth.

C. compressus (Pl. 34. fig. 19, side view; fig. 20, view from above). Compressed, obtusely triangular, truncate in front, subacutely gibbous at the back; marine; length 1-180″.

BIBL. Ehrenb. *Infus.* p. 395.

CYPREL'LA, De Koninck.—A fossil Ostracod, related to *Cypridina*; carapace annulated by superficial transverse furrows. Found in the Carboniferous Limestone of Belgium and the British Islands.

BIBL. De Koninck, *Carb. Foss. Belg.* 1844, 589; Jones, *M. Micros. Journ.* 1870, pl. 61. f. 10.

CYPRIDEL'LA, De Kon.—A fossil Ostracod closely allied to *Cypridina.* Very common in the Carboniferous Limestone of the British Isles and Belgium.

BIBL. De Koninck, *Carb. Foss. Belg.* 1844, 590; Jones, *M. Micr. Journ.* 1870, pl. 61. f. 9.

CYPRIDI'NA, M.-Edwards.—A genus of Ostracode Entomostraca, fam. Cypridinidæ.

Char. Valves oval or oblong, smooth, notched antero-inferiorly, posterior end somewhat produced. Superior antennæ seven-jointed; setæ of moderate length; natatory branch of inferior antennæ nine-jointed, bearing moderately long setæ; secondary branch very small, subulate. Basal joint of mandibular feet bearing an entire subconical and densely hairy process; penultimate joint much elongated, and beset on the internal margin with numerous ringed setæ; last joint very short and almost obsolete.

2 European species: *C. Norvegica* and *C. Messinensis.*

Many fossil forms, apparently identical with *Cypridina*, occur in the Mountain-limestone and the Coal-measures of Europe and the British Isles; some also in the Maestricht Chalk.

BIBL. Brady, *Zool. Proc.* 1871, p. 289; M.-Edwards, *Hist. Nat. Crust.* iii. p. 409.

CYPRIDOP'SIS, Br.—A genus of Ostracode Entomostraca, family Cypridæ.

Char. Those of *Cypris,* except that the postabdominal rami are rudimentary and setiform.

5 living British species. *C. vidua,* Br. = *Cypris vidua,* Bd.; *C. villosa,* Br. = *Cypris Westwoodii,* Bd.

Bibl. Brady, *Linn. Tr.* xxvi. 375; *Ann. Nat. Hist.* 1872, ix. 64.

CY'PRIS, Müller.—A genus of Ostracode Entomostraca, family Cypridæ.

Char. Lower antennæ simple, with a brush of setæ and clawed at the apex; setæ of upper antennæ very long; feet two pairs, the last bent up between the valves. Post-abdominal rami forming two elongate rami, clawed at the apex. Animal swimming freely.

Body enclosed within a bivalve, horny, mostly subreniform or long oval carapace or shell. Superior antennæ (Pl. 15. fig. 18) seven-jointed, with pretty long, mostly feathery filaments, arising from the three or four last joints. Inferior antennæ (fig. 19) leg-like, five-jointed, giving off the tuft of usually feathery filaments, the last joint terminated by four strong curved claws. Labrum composed of a somewhat hood-shaped piece, projecting between the two inferior antennæ; labium or lower lip elongated and triangular. Mandibles (fig. 20) large, pointed at one end, with five teeth at the other, and furnished with a three-jointed setigerous palp, the basal joint of which has a small branchial joint with five terminal digitations. First pair of jaws (fig. 21) consisting of a large basal plate (*a*), with four finger-like processes at its anterior extremity, one of which is two-jointed, and all terminated by several long filaments; from the outer edge of this plate arises a large elongated branchial lamina (*b*), giving off from its crescentic margin nineteen long pectinate spines. Second pair of jaws (fig. 22) small, and composed of two flattened joints, the terminal one having several rigid hairs at the end, and a lateral palp-like process. First pair of feet (fig. 23) slender and five-jointed, the last joint with a strong hook. Second pair of feet (fig. 24) four-jointed, the last joint terminated by two short hooks and a spur-like posterior filament.

Twenty-seven living British species.

C. virens (*tristriata*, Bd.) (Pl. 15. figs. 17–25). Shell oval, and somewhat reniform, posteriorly exhibiting three narrow oblique streaks or dark bands; valves convex, green, and covered with dense short hairs. Near the centre of each valve are about seven small lucid spots. Aquatic, very common.

Several fossil Ostracoda are referred to *Cypris* by palæontologists.

Bibl. Baird, *Brit. Entom.* p. 151; Straus, *Mém. d. Mus. d. Hist. Nat.* vii. 1821; Edwards, *Hist. Nat. Crust.* iii.; Brady, *Linn. Tr.* xxvi. p. 360, and *Ann. N. Hist.* 1872, ix. p. 64; Rup. Jones, *Mon. Tert. Entom., Palæont. Soc.* 1856; *Geol. Mag.* vii. p. 158.

CYSTIC OXIDE or CYSTINE.—A very rare component or constituent of urinary calculi in man and the dog. It also occurs in the urine, in solution and as a crystalline deposit.

Cystine is insoluble in water and alcohol; soluble in mineral acids, but not in acetic acid; also soluble in solutions of fixed alkalies, their carbonates, and in solution of ammonia. It is precipitated from its solution by acetic acid.

Its crystals form colourless, regular six-sided plates or prisms (Pl. 9. group 5); the larger crystals usually exhibit a number of smaller hexagonal tables irregularly arranged upon them; sometimes rectangular plates are met with. The crystals usually exhibit but little colour with polarized light. Cystine is most readily obtained in crystals from a calculus, by solution in ammonia and spontaneous evaporation.

Some of the forms of lithic acid prepared artificially, resemble those of cystine (Pl. 8. group 8 *b*); they may be distinguished by the addition of ammonia, which dissolves the cystine, but has little or no action upon the uric acid.

Carbonate of potash also somewhat resembles cystine in the form of its crystals (Pl. 6. fig. 13); but water or acetic acid will at once distinguish them.

Bibl. See the Bibl. of Chemistry, Animal.

CYSTICER'CUS, Rud.—A supposed genus of Entozoa, of the order Sterelmintha, and family Cystica.

Char. Individuals existing singly in a cyst, and composed of a short body of a *Tænia* with a double crown of hooks, and terminated posteriorly by a larger or smaller vesicle.

Head with four suctorial disks. Dujardin admits five species.

Recent researches have shown that the species of *Cysticercus* are the scolices of Tæniæ.

C. cellulosæ (Pl. 16. fig. 3). The scolex of *Tænia solium.* Head almost tetragonal; neck very short; body cylindrical, longer than the vesicle; breadth of cyst half an inch; length of body 1-6 to 2-5'' (or 1'' when extended). Occurs in the anterior

chamber and upon the conjunctiva of the eye, also in the voluntary muscles and brain of man; in the cellular tissue of the pig, producing the peculiar appearance of "measly pork;" also in the ape, the dog, the ox, the rat, &c.

C. fasciolaris (Pl. 16. fig. 3 *b*, head of). Occurs in the liver of the rat, the mouse, &c.

Bibl. Dujardin, *Hist. d. Helminth.* p. 632; Beneden, *Vers Cestoïdes*, &c., 1850; Cobbold, *Entozoa*.

CYS'TINE. See Cystic Oxide.

CYSTOCOC'CUS, Näg. = Protococcus.

CYSTO'DIUM.—A genus of Dicksonieæ (Polypodioid Ferns), with a curious false indusium.

CYS'TOPHRYS, Archer.—A genus of Rhizopoda.

2 species: *C. Häckeliana* and *C. oculea*.

Bibl. Archer, *Qu. Mic. Jn.* 1869, p. 259.

CYSTOP'TERIS, Bernhardi.—A genus of Asplenieæ (Polypodioid Ferns), containing several elegant little indigenous species (fig. 154).

Fig. 154.

Cystopteris ragilis.
A pinnule with the sori covered by the indusia.
Magnified 10 diameters.

CYS'TOPUS, Léveillé.—A genus of Uredinei (Coniomycetous Fungi), of which the 'white rust' common on cabbages and other Cruciferous plants is a good example, appearing in white pustules, eventually bursting and destroying the epidermis of the leaves, stalks, flowers, and seed-vessels of the infected plants. When fine slices of these pustules are examined under the microscope, the mycelium is found, creeping among the cells of the parenchyma, composed of inarticulate, tubular, branched filaments, with a colourless membrane and whitish granular contents. Numerous ramifications spread out in the plane of the epidermis; while others spring up in tufts of two to seven, or rarely singly, perpendicular to the former, to produce spores. These erect branches are at first mere pouches projecting from the horizontal filaments; they gradually swell into ovate-cylindrical or club-shaped sacs. The contents in the summit of each such sac become organized into a spore, which at length quite fills up the top of the sac (sporange). Then the sac or sporange becomes constricted under this first spore, and the formation of a second commences under the constriction. This is repeated until a necklace-like chain of spores is produced, the spores subsequently becoming somewhat cylindrical or cubical. The number appears indefinite; five and seven spores have been found in a chain; they are united by the constricted portions of the sporange; and even when they have fallen apart, these connecting pieces are seen projecting on them like parts of a stalk from which they have been broken off. Both the adherent sporangial membrane and the smooth proper coat of the spores are colourless, the contents granular and whitish. Tulasne has recently discovered another form of spore, spheroidal or trigonal, and of a yellow colour, only one or two of which are formed from the end of a fertile filament. Oospores are also found deeply seated amongst the mycelium; and zoospores have been found by De Bary in *C. candidus*. See Uredinei. British species:

C. candidus, Lév. Very common on Cruciferæ, producing great distortion in the growth. *Uredo candida*, Pers., Grev. *Sc. Crypt. Fl.* t. 251.

C. cubicus, Str. On goatsbeard. Cooke, *Exs.* no. 88.

C. Sepigoni, De By. On *Spergularia rubra*. Cooke, *Exs.* no. 88.

C. spinulosus, De By. On *Cirsium arvense*. Cooke, *Exs.* no. 89.

Bibl. Léveillé, *Ann. des Sc. Nat.* 3 sér. viii. 369; Berkeley, *Hort. Trans.* iii. 265 (figs.); De Bary, *Brandpilze*, Berlin, 1853, p. 20, pl. 2. figs. 3–7, and *Ann. d. Sc. Nat.* 1863, xx. p. 130 (zoospores); Tulasne, *Ann. des Sc. Nat.* 4 sér. ii. 108, 171.

CYSTOSEI'RA, Ag.—A genus of Fucaceæ (Fucoid Algæ), of much-branched habit, some species of which are common on rocks in tide-pools or between tide-marks. The gradually attenuated branches contain inflated air-sacs, at intervals along their length, within their substance. The conceptacles

are immersed in the ends of the branches, which are pierced by their numerous pores. They contain both spores and antheridia, but not mixed; the spores occur at the bottom of the cavity, the antheridia above, near the pore. The antheridia have only a single coat. The antherozoids are expelled in a mass, and soon after begin to move, turning rapidly upon their axes. They are oval or spherical in one direction, and rather compressed in the other. They have two cilia inserted on a red granule; the long cilium in front moves rapidly, while the posterior short one is motionless. See FUCACEÆ.

BIBL. Harvey, *Br. Mar. Alg.* pl. 1 B; *Phyc. Brit.* 133, &c.; Thuret, *Ann. des Sc. Nat.* 3 sér. xvi. pp. 7 & 10.

CYSTOT'RICHA, Berk. and Broome.—A supposed genus of Sphæronemei (Coniomycetous Fungi). Minute fungi forming dots or lines upon wood from which the bark has been stripped. Only one species is described.

C. striola, Berk. and Br. Perithecia black, with a reddish tinge, opening by a reddish disk.

BIBL. Berk. and Br. *Ann. Nat. Hist.* 1850, v. p. 457, pl. 12. fig. 10.

CYTHE'RE, Müll.—A genus of Entomostraca, of the order Ostracoda, and family Cytheridæ.

Char. Shell usually hard, calcareous, rough and uneven; mouth with a lip and labrum; masticatory organs well developed; mandibles toothed at the end; lower antennæ four-jointed; upper antennæ five-jointed, last three joints elongated, spiniferous; feet in the male and female alike; internal lobe of the first pair of maxillæ well developed. Not capable of swimming.

Those having the valves almost regularly oblong, with the surface very irregular, being wrinkled, ridged, and beset with tubercles, and crenulate or strongly toothed on the margin, have been separated by Rupert Jones under *Cythereis.*

46 living British species. Many fossil Cytheræ are recorded, which, however, most probably belong to allied genera, undistinguishable by the valves alone. Brady records 22 species as occurring in posttertiary deposits of Britain.

BIBL. Baird, *Brit. Entom.* p. 163; Brady, *Linn. Trans.* xxvi. p. 394, and *Ann. Nat. Hist.* ser. 4. ix. p. 68; *Zool. Tr.* v. 376.

CYTHERE'IS, Rup. Jones. See CYTHERE.

CYTHEREL'LA, R. Jones and Bosquet.—A genus of Ostracode Entomostraca, family Cytherellidæ.

Char. Valves unequal, very thick and calcareous, not notched in front. Upper antennæ very large, seven-jointed, and geniculate at the base; lower broad, flattened, and two-branched; mandibles very small, with a large pectinato-setose palp; three pairs of hinder limbs, scarcely pediform, the two anterior pairs branchial, the others rudimentary. Abdomen terminating in two very small, narrow, spiniferous laminæ. Ova and embryos borne beneath the shell of the female.

2 living British species, *C. scotica* and *C. lævis*; from deep dredging in the Minch. Numerous fossil species, from the Carboniferous to Tertiary strata inclusive.

BIBL. Brady, *Linn. Tr.* xxvi. p. 472; *Zool. Tr.* v. 362; R. Jones, *Mon. Cret. Entom.* 1849, p. 28; *Mon. Tert. Entom., Palæon. Soc.* 1856, p. 54.

CYTHERELLI'NA, Jones.—An obscure fossil Ostracod, very common in the Upper Silurian strata of Britain and Europe.

BIBL. R. Jones, *Ann. N. Hist.* ser. 4. iii. p. 215.

CYTHERIDEA, Bosquet.—A genus of Ostracode Entomostraca, family Cytheridæ.

Char. Shell subtriangular, thick and compact, smooth, pitted, papillose or rugose. Mouth with a lip and labrum; masticatory organs well developed; mandibles toothed at apex; lower antennæ four-jointed; upper five-jointed, last three joints elongated, spiniferous; feet in male and female unlike; right foot of first pair in the male prehensile, right of the second pair weak and rudimentary.

10 living British species. Several fossil Cretaceous and Tertiary species.

BIBL. Brady, *Linn. Trans.* xxvi. p. 421; *Zool. Tr.* v. 370; R. Jones, *Mon. Tert. Entom., Pal. Soc.* 1856, p. 40, and *Geol. Mag.* vii. 76, 158.

CYTHERIDE'IS, Jones.—A subgenus of Ostracode Entomostraca.

1 living British species, *C. subulata*; some fossil reputed species, Cretaceous and Tertiary.

BIBL. Jones, *Mongr. Tert. Entom., Palæontog. Soc.* 1856, p. 46 (shell); Brady, *Ann. Nat. Hist.* 1872, ix. p. 58 (animal).

CYTHEROPSIS, Sars = *Eucythere*, Brady.

CYTHEROP'TERON, Sars.—A genus of Ostracode Entomostraca.

Char. Valves of shell unequal, with pro-

minent lateral alæ. Mouth with labium and labrum; masticatory organs well developed; mandibles toothed; lower antennæ five-jointed; upper five-jointed; postabdominal lobes broad and short, with three setæ; eyes none.

9 living British species. Also some Cretaceous and Tertiary species.

Bibl. Brady, *Linn. Trans.* xxvi. p. 447, and *Ann. Nat. Hist.* 1872, ix. p. 61; R. Jones, *Geol. Mag.* vii. 76 and 158.

CYTHERU'RA, Sars.—A genus of Ostracode Entomostraca.

Char. Shell oblong or subtriangular; posterior extremity prolonged into a beak. Superior antennæ six-jointed, shortly setose, tapering; inferior antennæ five-jointed; terminal claws short; mandibles robust; teeth blunt; eyes two.

24 living British species; also some Cretaceous and Tertiary species.

Bibl. Brady, *Linn. Trans.* xxvi. 439, and *Ann. Nat. Hist.* 1872, ix. p. 55; R. Jones, *Geol. Mag.* vii. 77, 158.

CYTIS'PORA, Ehrenb.—A genus of Sphæronemei (Coniomycetous Fungi), remarkable for emitting the minute bodies formerly regarded as spores, agglutinated together into a more or less gelatinous mass, in the form of a tendril. The relationship between the forms called *Cytispora* and various species of *Sphæria* has long been noticed; and Fries stated that he had seen *C. leucostoma* pass into *S. leucostoma*. *C. fugax* was stated by Berkeley to be exactly analogous to *S. salicina*. Recent researches seem to prove that the present genus, with *Septoria* and others, are really only forms belonging to various Ascomycetous Fungi, and that they bear the same relationship to the latter as the spermogonia of Lichens do to the theciferous fructification. Hence the so-called spores of *Cytispora* &c. appear in reality to be the *spermatia* or *stylospores* of the Sphæriacei. As these questions are not yet completely worked out, we retain the names of these pseudo-genera and species in the present work. See Sphæriacei.

1. *Cytispora rubescens*, Fr. Disk dirty brown; spores (?) reddish. On Rosaceæ.

2. *C. chrysosperma*, Pers. Disk black; spores yellow. On Poplar bark.

3. *C. carphosperma*, Fr. Disk dingy; spores straw-coloured. On Hawthorn and other Rosaceæ.

4. *C. leucosperma*, Pers. Disk dirty white; spores white. On various trees. Common. *Nemasporum rosarum*, Grev. *Scot. Crypt. Fl.* t. 20.

5. *C. fugax*, Bull. Disk dirty brown; spores pale. On willow branches. Very common.

6. *C. orbicularis*, Berk. Disk yellowish; spores pale vinous red. Upon small orange gourds. Berkeley, *Ann. Nat. Hist.* i. pl. 7. fig. 6.

7. *C. Hendersoni*, Berk. and Broome. Disk whitish; spores large, dirty white. On Dog-rose. Berk. and Br. *Ann. Nat. Hist.* 2 ser. v. 379.

C. pulveracea, Berk. *Br. Flora* = *Ceuthospora Phacidioides*, Desm.

Bibl. Berkeley, *Brit. Flor.* vol. ii. pt. 2. p. 281, *Crypt. Bot.* p. 331; Berk. and Broome, *Hooker's Jn. of Bot.* iii. 319; Tulasne, *Ann. des Sc. Nat.* 3 sér. xv. p. 375 (*Ann. Nat. Hist.* 2nd ser. viii. 114); *Ann. des Sc. Nat.* xx. p. 129; *ibid.* 4 sér. v. p. 115; *Bot. Zeit.* xi. 49 (1853).

CYTOBLAST. See Nucleus.

CYTOBLASTEMA, or, for brevity, Blastema, or Protoplasm.—The amorphous proteine-substance by which animal and vegetable cells are formed, or of which they are wholly composed. See Cells, and Protoplasm.

CY'TODE.—A term applied by Häckel to an organism consisting of a simple lump of sarcode = to our protoplast (1856).

Bibl. Häckel, *Gen. Morph.* i. p. 269.

D.

DACRY'MYCES, Fries.—A genus of Tremellini (Hymenomycetous Fungi), consisting of lobulated gelatinous bodies growing upon wood. *D. stillatus*, a common species, is yellow or red, turning brown when dried. Tulasne has recently published some curious observations on this genus, showing that the spores produced on the basidia of the external hymenial layer, are of two kinds, and, while one kind germinates, the other kind produces minute stalked bodies, one from each chamber of the septate spore, destitute of germinative power (*spermatia* ?).

Bibl. Berkeley, *Hook. Brit. Fl.* v. pt. 2. p. 219; *Crypt. Bot.* p. 353; Greville, *Sc. Crypt. Fl.* pl. 159; Tulasne, *Ann. des Sc. Nat.* 3 sér. xix. 211, pl. 12 & 13.

DACTYLI'NA, Nyl.—A doubtful genus of Lichens.

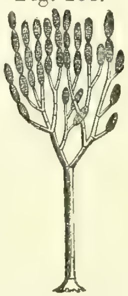
1 species, *D. arctica*, Hook. A singular

fungus-looking plant, inhabiting Arctic America.

Bibl. Leighton, *Linn. Journ.* ix. p. 192, pl. 2. fig. 11–17.

DACTYL'IUM, Nees.—A genus of Mucedines (Hyphomycetous Fungi), nearly allied to *Trichothecium*, consisting of moulds growing over decaying plants. Fries refers Corda's species of *Dactylium* to *Dendryphium*. One species, *Dactylium oogenum*, Montagne, is remarkable for its place of occurrence: it grows upon the surface of the membrane within the shell of the eggs of fowls and other birds. It does not appear to have been observed in this country; but several foreign writers have investigated it; and from the experiments made by Spring and Wittich, it appears that the spores pass through orifices existing in the shell, and germinate in the interior, often in the air-chamber. A full account of this plant, and of the literature, is given by Ch. Robin. Many of the species are undoubtedly conidiiferous forms of *Sphæriæ* (Tulasne, *Carpologia*). See Dendryphium and Helminthosporium. British species:

Fig. 155.



Dactylium atrum. A fertile filament with septate spores upon its branches. Magn. 200 diams.

1. *D. pyriforme*, Fr. On mouldering stems of herbaceous plants.
2. *D. macrosporum*, Fr. On rotton wood, leaves, and fungi.
3. *D. dendroides*, Fr. On decaying agarics, &c. Very common. Grev. *Sc. Crypt. Fl.* pl. 126. fig. 1.
4. *D. obovatum*, Berk. On willow twigs, in damp. *Ann. Nat. Hist.* vi. pl. 14. fig. 26.
5. *D. sphærocephalum*, Berk. On dead ivy-twigs, *l. c.* fig. 27.
6. *D. tenellum*, Fr. On moss.

Bibl. Berk. in *Hook. Brit. Fl.* v. pt. 2. p. 345; *Ann. Nat. Hist. ut supra*; Berk. and Broome, *Ann. Nat. Hist.* 2 ser. vii. p. 102; Ch. Robin, *Végét. Parasites*, 2nd ed. 543, pl. 2. figs. 5 & 6; Fries, *Syst. Myc.* iii. p. 414; *Summa Veget.* 491.

DACTYLOCOC'CUS, Näg.—A genus of Palmellaceous Algæ.

Bibl. Nägeli, *Einz. Alg.* p. 85; Rabenhorst, *Fl. Alg.* iii. p. 46 (fig.).

DACTYLOPORA, Lam.—One of the Foraminifera imperforata. The simplest form presents a set of sac-like chambers, side by side, for a part or the whole of a circle, with their mouths in one direction along the inner median line. Various modifications lead to the structure of a cylinder of such rings, with interspaces, thickened walls, and subsidiary cavities. The simple forms (*D. eruca*, Pl. 18. f. 53) live in the tropical seas. The more complicated species are of Tertiary age in France, Italy, and San Domingo; *D. reticulata* (Pl. 18. f. 54) is one of these.

Bibl. Parker and Jones, *Ann. N. H.* ser. 3. v. 473; Carpenter, *Introd. For.* 127.

DACTYLOPUS, Claus.—A genus of Entomostraca, order Copepoda.

D. tisboides. Marine.

Bibl. Claus, *Copepod.* p. 127; Brady, *Trans. Northumberland, &c.*

DALTO'NIA, Hook. and Tayl.—A genus of Pleurocarpous Mosses, the species given being restored here on account of the structure of the leaf, while *D. heteromalla* of Hooker goes to *Hypnum* on the same ground.

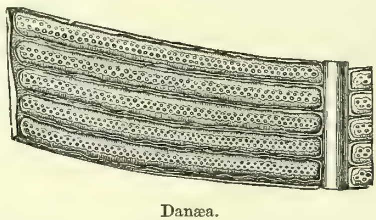
D. splanchnoides, Hook. and T. = *Hookeria splanch.*, Hook.

DAMÆ'US, Koch. See Belba.

DAM'MARA-"*Gum.*" — The resin of *Dammara australis*, N. O. Pinaceæ, is often used, dissolved in benzole, as a varnish; but it is very apt to crack, and therefore not to be recommended.

DANÆ'A, Smith.—A genus of Marattiaceous Ferns, whence the family is sometimes called also Danæaceæ. Exotic.

Fig. 156.



Danæa.
Part of a pinnule with sori.
Magnified 5 diameters.

DAPH'NE, L. See Thymeleaceæ.

DAPHNEL'LA, Baird. — A genus of Entomostraca, of the order Cladocera, and family Daphniadæ.

Char. Inferior antennæ very large, posterior branch two-jointed only.

D. Wingii (Pl. 15. fig. 27). Aquatic.

Bibl. Baird, *Brit. Entomos.* p. 109.

DAPH'NIA, Müll.—A genus of Entomostraca, of the order Cladocera, and family Daphniadæ.

Char. Head produced into a more or less prominent beak; superior antennæ situated beneath the beak, either one-jointed or consisting of a minute tubercle with a tuft of short filaments; inferior antennæ large and powerful, two-branched, one branch three-jointed, the other four-jointed; five pairs of legs.

Valves of the carapace finely reticulated, and terminated below by a longer or shorter serrated spine. Anterior branch of inferior antennæ (Pl. 15. fig. 28 *b*) four-jointed, first joint very short; from the end of the third a long filament arises, and the fourth joint is terminated by three others; posterior branch three-jointed, the first and second joints sending off a long filament, the third terminated by three of them; the filaments are jointed near the middle, and usually feathery. Eye spherical, with about twenty lenses. Labrum (Pl. 15. fig. 35) flattened, and with a large hairy lobule at the end. Mandibles (Pl. 15. fig. 34) consisting of a fleshy-looking body, bent inwards near the end, and terminated by numerous minute teeth. Jaws (Pl. 15. fig. 36) composed of a strong body terminated by four horny spines, three of which are curved inwards. Legs five pairs, those of the first pair in the female (Pl. 15. fig. 29) three-jointed; upon the outer edge of the second joint are three small projections, each with four or five long jointed setæ; terminal joint very small, and with one or two similar setæ; the setæ not plumose. In the male they are more slender, with a strong claw at the end of the second joint, while the seta arising from the terminal joint is very long, nearly the length of the body, and floats outside the shell.

The second (Pl. 15. fig. 30), third (fig. 31) and fourth (fig. 32) pairs of legs are branchial and somewhat similar, the joints furnished with jointed and mostly plumose setæ, and a branchial plate also giving off numerous plumose setæ. The fifth pair of legs (fig. 33) are three-jointed, the portion corresponding to the branchial plate rounded and without filaments; above this is a curved, jointed, and plumose spine, the third and fourth joints forming finger-like processes springing from the lower end of the leg, with two or three plumose setæ. The branchial legs are constantly in motion during life; and this gives rise to the quivering appearance seen in the *Daphniæ* with the naked eye or a simple lens.

The ova on their escape from the body become lodged between the back of the animal and the shell, where they remain until completely hatched; but at certain seasons of the year ephippial or winter-ova (Pl. 15. fig. 37) are produced (ENTOMOSTRACA).

According to Lubbock's observations, the latter only are true ova; although both kinds become hatched and perfectly developed, this may occur without impregnation.

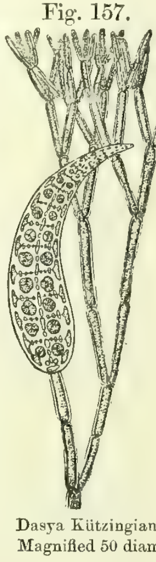
Seven British species of *Daphnia* are recognized: some of them may be found in almost every collection of water, which they frequently colour.

D. pulex (Pl. 15. fig. 28) (common water-flea). Valves oval, their dorsal margin not serrated; head large, rounded above and in front; superior antennæ (Pl. 15. fig. 28 *a*) very small; filaments of inferior antennæ plumose; posterior portion of abdomen with four projections at its curve, the first prolonged and bent upwards; below these are two jointed filaments; the end portion has two dentate arches, and terminates in two strong hooks.

Some other species are common; but their essential characters have not been briefly expressed.

BIBL. Baird, *Brit. Entom.* p. 89; Lubbock, *Ann. Nat. Hist.* 1857, xx. 257; Leydig, *Naturgeschicht. d. Daphnid.* 1860.

Fig. 157.



Dasya Kützingiana. Magnified 50 diams.

DARWINEL'LA, Brady (=*Polycheles*, B.).—A genus of Ostracode Entomostraca.

1 British species: *D. Stevensoni.*

BIBL. Brady, *Ann. Nat. Hist.* ser. 4. vi. p. 25.

DA'SYA, Ag.—A genus of Rhodomelaceæ (Florideous Algæ), consisting of tufted filamentous sea-weeds, of a red, brown, or purple colour, growing on rocks near low-water mark. The principal filaments are stoutish, branched, and clothed with branched ramules, upon which are borne the *stichidia* containing tetraspores (fig. 157), or *ceramidia* containing spores,

on distinct plants. Four British species are recorded, of which *D. coccinea* and *D. Arbuscula* are the commonest. The wood-cut (from Kützing) represents a branched ramule bearing a stichidium with two rows of tetraspores, from an Italian species.

BIBL. Harvey, *Brit. Mar. Algæ,* 93, pl. 12 B; *Phyc. Brit.* pl. 40. 224, 225 & 253.

DASY'DYTES, Gosse.—A genus of Rotatoria, of the family Ichthydina.

Char. Eyes absent; body furnished with bristle-like hairs; tail simple, truncate.

1. *D. goniathrix.* Hairs long, each hair bent at an abrupt angle; neck constricted; length 1-146″; aquatic.

2. *D. antenniger.* Hair short, downy; a pencil of long hairs at each angle of the posterior extremity of the body; head with two club-shaped organs resembling antennæ; length 1-170″.

BIBL. Gosse, *Ann. Nat. Hist.* viii. 1851, p. 198.

DASYGLŒ'A, Thwaites (in Kützing).—A genus of Oscillatoriaceæ (Confervoid Algæ), forming a shapeless gelatinous stratum in marshy places; filaments sheathed, open at the ends. One species is described.

D. amorpha, Berk. (Pl. 4. fig. 11). Filaments curled and entangled, sheaths very large, 1-220 to 1-50″.

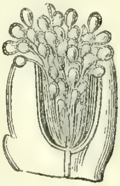
BIBL. *Eng. Botany, Supp.* 2941; Kützing, *Species Alg.* p. 272; *Tab. Phycol. Cent.* i. pl. 72. fig. 2.

DAVAL'LIA, Sm. See DAVALLIEÆ.

DAVALL'IEÆ.—A subtribe of Polypodioid Ferns.

Fig. 158.

Fig. 159.



Davallia pyxidata.

A pinnule with sori. Magn. 5 diams.

A sorus with the indusium cut open. Magn. 15 diam.

Illustrative Genera.

1. *Davallia.* Sori globose, infra-marginal; indusium somewhat urn- or cup-shaped, the mouth truncated (figs. 158 and 159). Veins pinnate.

2. *Lindsæa.* Sorus linear, infra-marginal, continuous; indusium linear, elongated, continuous, parallel with the margin of the leaf, free outside. Veins dichotomous.

3. *Dictyoxiphium.* Sorus and indusium as in No. 2. Veins anastomosing, with free venules.

4. *Schizoloma.* Sorus and indusium as in No. 2. Veins anastomosing in hexagonoid meshes.

DEGENERATION, FATTY.—The abnormal deposition of free fatty matter in the histological elements of animal bodies.

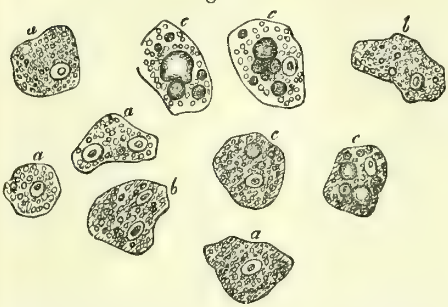
When, from whatever cause, the normal functions of the morphological elements of a tissue—cells, or the secondary deposits formed in them—become languid or interrupted, free globules of fat or oil become visible in them; and as the deposition of this fatty matter increases in amount, the tissue loses to a greater or less extent its natural vital and physical properties; hence it is said to be in a state of fatty degeneration. The discovery of the fatty degeneration of tissues is probably one of the most valuable fruits of microscopic study in regard to medical science; for it has shown us that maladies supposed formerly to arise from too great abundance of the circulating fluid, have really had their origin in a decayed state of the tubes or vessels in which the fluid was contained, and that the natural process of human decay, as it is called, is a morbid process or disease, probably to a certain extent as remediable or preventible as many other diseases to which man is naturally liable. Here is indeed a matter of deep interest.

In addition to the deposition of fat within the elements of a tissue undergoing fatty degeneration, amorphous finely granular proteine-matters are sometimes found; occasionally also brown, yellow, red, or black granular pigment is met with (pigmentary degeneration), together with amorphous or crystalline calcareous salts, as the carbonate and phosphate of lime &c. (calcareous degeneration); sometimes the fatty matter is crystalline, it then generally consists of cholesterine.

Fatty degeneration of cells is well seen in those of the liver when undergoing this change. In the normal state, these as well as most cells, except those of true fatty tissue, contain merely one or two very minute or no globules of fat,—whilst in the degenerated tissue they contain a considerable number of larger or smaller globules (fig. 160). At the same time, the cell-walls and nuclei become thinner and paler, or atrophied. A similar state to that which is

abnormal in man is normal in the lower animals. Sometimes the substance intervening between cells becomes degenerated, and thus

Fig. 160.



Cells of the human liver: *a*, nearly normal cells; *b*, cells with pigment granules; *c*, cells containing fatty matter.
Magnified 400 diameters.

we have intercellular fatty degeneration (Pl. 30. fig. 15). Other instances of fatty degeneration are noticed under the respective heads of the tissues &c., as the Graafian vesicles and the cells of the corpora lutea (Ovary), the epithelia of the mucous and serous membranes, and of the various glands, the vessels, the exudation-corpuscles of inflammation, the muscles, &c.

The fatty degeneration of the capillaries is represented in Pl. 30. fig. 13. In the larger blood-vessels, when reaching a more advanced degree, it forms atheroma.

It might appear paradoxical to regard the presence of numerous fat-globules, in such instances as the cells of cancer, and the exudation-cells of inflammation, where the vital processes are so evidently augmented, as indicating a state of degeneration. But in these, as in other instances, the functions of the cells, after the latter have attained their full development, cease, and the cells undergo degeneration and decay.

The free fatty matter is probably derived in general from the liberation of that previously dissolved in the contents of the cell; but it may be produced by the formation of fatty matter from the proteine or other constituents of the cell-contents. It is curious that portions of the flesh and other proteine-components of one animal, when kept in the peritoneal cavity of another living animal, will undergo fatty degeneration. The formation of adipocire is probably an instance of post-mortem fatty degeneration. See Fat.

Bibl. Virchow, *Path. Cell. (Picard)* 1861; Wedl, *Grundzüge d. Path. Hist.*; Forster, *Handb. d. Spec. Path. Anat.*; Wagner, *Nachr. d. Ges. d. Wiss. z. Göttingen*, 1851 (*Chem. Gaz.* ix. p. 309); Green, *Path. &c.* 1871; Rindfleisch, *Lehrb. d. Path. Geweb.*

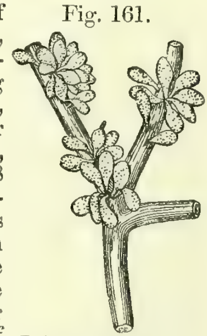
DELAVA'LIA, Brady.—A genus of Entomostraca, order Copepoda.

D. palustris. Northumberland.

Bibl. Brady, *Trans. Northumberland &c.*

DELESSE'RIA, Lamx.—A genus of Delesseriaceæ (Florideous Algæ), consisting of sea-weeds with a flat, membranaceous, rose-coloured frond, having a percurrent midrib, growing on rocks or on other larger Algæ, mostly from 2 to 8 inches high. Six species are described as British, most of them common. The leaf-like lobes of the frond arise from a kind of stalk, or from the midribs of older lobes. The texture is densely parenchymatous throughout.

Fig. 161.



Delesseria sanguinea.
Midribs of fronds in winter bearing sporophylls.
Nat. size.

D. sanguinea ripens its fruit in the winter; and then the membranous part of the fronds decays, leaving the midribs clothed with tufts of the *sporophylls* or leafy lobes containing the tetraspores (fig. 161), and stalked coccidia containing the spores. The fructification is somewhat similar in *D. alata*, while in *D. sinuosa* the coccidia are immersed in the frond, and the tetraspores in cilia-like processes fringing its margin; and in *D. Hypoglossum* the coccidia are seated on the midrib, and the tetraspores arranged in longitudinal linear rows like sori on each side of the midrib.

Bibl. Harvey, *Brit. Mar. Algæ*, p. 113, pl. 15 A; *Phyc. Brit.* pls. 2, 26, 83, 151, 247, 259; Greville, *Alg. Brit.* pls. 72–74, 76.

DELESSERIA'CEÆ.—A family of Florideæ. Rosy or purplish red, or blood-red sea-weeds, with a leafy, or rarely filiform, areolated, inarticulate frond, composed of polygonal cells. Lobes of the frond delicately membranous. *Fructification* double: 1. *Conceptacles* (*coccidia*) external, or half-immersed, hemispherical, usually imperforate, containing beneath a membranous pericarp a tuft of dichotomous filaments, whose articulations are finally changed into spores.

2. *Tetraspores* in distinctly definite *sori*, either scattered through the frond or placed in proper fruit-lobes or *sporophylls*.

Synopsis of British Genera.

1. *Delesseria.* *Frond* leafy, of definite form, with a percurrent midrib.
2. *Nitophyllum.* *Frond* leafy, of indefinite form, without a midrib (sometimes traversed by vague, vanishing nerves).
3. *Plocamium.* *Frond* linear or filiform, compressed, much branched, distichous; ramuli pectinate, secund.

BIBL. See the genera.

DEMATIE'I.—A family of Hyphomycetous Fungi, growing on the dead parts of plants, and characterized by the mostly septate spores being attached to rigid thick-walled filaments, which are continuous or septate.

According to the observations of Tulasne, many of the supposed genera of this family are merely conidiiferous states of Ascomycetous Fungi; for instance *Cladosporium*. We enumerate them here according to the older arrangement, as their history is not yet fully cleared up.

Synopsis of British Genera.

1. *Cephalotrichum.* Fertile filaments stalk-like, erect, septate, terminating in a globose capitule formed by radiating forked or ternate branches bearing globular spores at their tips.
2. *Sporocybe.* Filaments rather fibrous, subulate, capitate, bearing simple spores conglobated into a terminal head.
3. *Œdemium.* Filaments rigid, erect, almost continuous, or annulated, bearing at the sides globular masses of spores.
4. *Myxotrichum.* Filaments erect, scarcely septate; fertile branches crowned by globules of heterogeneous conglutinated spores.
5. *Helminthosporium.* Filaments erect, simple, septate; spores transversely septate.
6. *Bolacotricha.* Filaments simple, uniformly articulate at the apex; spores conglomerated, large, globular, shortly stalked, contents distinctly granular.
7. *Triposporium.* Filaments erect, septate, sterile branches solitary, more or less spreading; fertile branches shorter, bearing at the tips solitary, stellate, mostly very shortly stalked spores.
8. *Helicosporium.* Filaments erect, subulate, closely septate, continuous and diaphanous at the summit; spores thread-like, septate, spirally coiled, then expanding themselves with elasticity.
9. *Cladotrichum.* Filaments erect, septate, branched; branches and branchlets bearing septate spores at their tips.
10. *Dematium.* Filaments erect, septate, with verticillate branchlets below, simple and whip-like above; spores crowded on the apices of the ramules.
11. *Cladosporium.* Filaments erect, septate above, bearing the spores arranged in rows forming short moniliform branchlets.
12. *Macrosporium.* Filaments suberect, septate, delicate, evanescent, bearing erect, stipitate spores, with many transverse and usually some longitudinal septa.
13. *Arthrinium.* Filaments tufted, suberect, annulate, with opaque thickish septa; spores fusiform, septate, large.
14. *Camptoum.* Filaments as in the preceding; spores ovate, curved, small.
15. *Arthrobotryum.* Common stem composed of jointed filaments. Spores large, radiating, so as to form a little head, dark, septate.
16. *Dendryphium.* Filaments free, jointed, simple below, branched above; branches and branchlets often monilioid; spores septate, acrogenous, concatenated.
17. *Periconia.* Stem composed of fasciculated compacted filaments; head globose; spores fixed to the free tips of the filaments.
18. *Haplographium.* Filaments jointed, free, black; spores concatenate, hyaline.
19. *Monotospora.* Filaments free, black, bearing one or rarely two (by division) large, black, subglobose spores at their tips.
20. *Helicoma.* Filaments erect, dark, jointed, bearing on their sides pale, flat, spiral spores.
21. *Polythrincium.* Filaments moniliform; spores springing from the midst of the filaments, didymous.
22. *Gonatosporium.* Filaments erect, jointed, thickened at the articulations; spores irregularly biconical, somewhat angular, attached in whorls.
23. *Sporodum.* Filaments erect, jointed; threads of inarticulate spores moniliform, seated towards their base.

Allied or uncertain Genera.

Blastotrichum. Pedicels ascending or floating, very much branched, continuous; spores oblong, transversely septate.

Stachyobotrys. Pedicels branched, sep-

tate; branches crowned at the tips with whorls of mammillary very short branchlets forming a capitulum; spores didymous.

Helicotrichum. Filaments creeping, branched, septate only at the tips; spores spirally curled, somewhat septate.

DEMA'TIUM, Pers.—A genus of Dematiei (Hyphomycetous Fungi), growing upon

Fig. 162. Fig. 163. Fig. 164.

Dematium griseum. Magnified 200 diameters.

dry leaves, bark, &c., distinguished by the sporiferous branchlets arising closely together near the base of the erect filaments. British species:

1. *D. griseum*, Pers. (figs. 162–4). On rotten hazel-stumps. *Chætopsis Wauchii*, Grev. *Sc. Crypt. Fl.* pl. 236. See ECHINOBOTRYUM.

BIBL. Berk. *Hook. Brit. Fl.* v. pt. 2. p. 338; *Ann. Nat. Hist.* i. 260, vi. 435; Grev. *l. c.*; Fries, *Sum. Veg.* 499; Corda, *Icon. Fung.* i. pl. 4. figs. 242, 243.

DEMO'DEX, Owen (*Simonia*, Gerv.).—A genus of Arachnida, the exact systematic position of which is doubtful, although usually placed in the family Acarina.

Char. Legs terminated by four or five claws (only one, Beck), no acetabula; abdomen annulose.

D. folliculorum (Pl. 2. fig. 42), the *Acarus*, *Simonia*, or *Entozoon folliculorum* of some authors, inhabits the sebaceous and hair-follicles of the human skin. The minute size of the various parts renders it extremely difficult to isolate them. It varies in length from about 1-150 to 1-50″.

At the anterior part of the body are two two-jointed organs (Pl. 2. fig. 43 *a*), the basal joint longest, the distal smallest, and probably terminated like the feet by claws; these appear to represent palpi. Between these are two narrow elongated organs (fig. 43 *b*), the nature of which is doubtful; by some they are regarded as forming a suctorial rostrum, by others as constituting maxillæ or mandibles. Above these is a triangular labrum (fig. 43 *c*); a labium has also been described.

Above or upon the basal joint of the palpi are two minute tubercles, one on each side (fig. 43 *d*). Similar tubercles are seen upon the dorsal surface of the thorax, between the second and third, and the third and fourth pairs of legs.

On each side of the thorax are four pairs of very short conical legs; these are apparently three-jointed, and marked by irregular fine transverse striæ.

The abdomen is longer than the thorax, tapers posteriorly, and exhibits indications of transverse rings, in the form of numerous delicate transverse lines.

These animals may be obtained by pressing out the contents of the follicles existing upon the sides and alæ of the nose, especially when these appear enlarged, whitish, and exhibit a terminal black spot. A drop of oil should then be added to the secretion, and the whole allowed to macerate for some hours at a gentle heat. Or the secretion may be digested in a mixture of alcohol and ether, to dissolve the fatty matter, and then treated with solution of potash.

The secretion contains the ova, the young animals, and the exuviæ. When contained in the follicles, the tail is directed towards their orifice.

A species of *Demodex* was found by Topping in the pustules of the skin of a dog affected with the "mange." This appears to agree in structure with *D. folliculorum*; but its average size is less, amounting to 1-150 to 1-100″ in length. It does not appear to constitute a distinct species; for Gruby found that, by inoculating the dog with the human parasite, a disease resembling, if not identical with, the mange was produced.

BIBL. Simon, *Müller's Archiv*, 1842, p. 218; Owen, *Hunt. Lect.* i. p. 251; Gervais, *Walckenaer's Aptères*, iii. p. 282; Wilson, *Tr. Roy. Soc.* 1844, p. 305; Tulk, *Ann. Nat. Hist.* 1844, xiii. p. 75; Gruby, *Ed. Month. Journ.* vii. p. 333; Wedl, *Path. Hist.* p. 803; R. Beck, *The Achr. Micr.* p. 6, pl. 24. fig. 1 (*excellent*).

DENDRITI'NA, D'Orb.—The nautiloid, or compactly discoidal, condition of *Peneroplis.* Common in tropical seas.

BIBL. Carpenter, *Introd. For.* 88.

DENDROCOME'TES, Stein.—A doubtful genus of Acinetina. The single species,

D. paradoxus (Pl. 25. fig. 36), is supposed by Stein to constitute the resting stage or *Acineta*-form of *Spirochona gemmipara.* It is found upon the gill-plates of *Gammarus pulex*.

BIBL. Stein, *Siebold and Kölliker's Zeitschr.* 1852, iii. p. 492; id. *Die Infus.* p. 205.

DENDROSO'MA, Ehr.—A genus of Rhizopoda, of the family Acinetina.

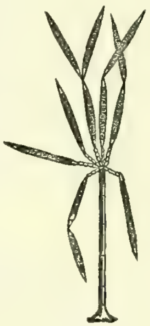
Char. Consists of a thick branched pedicle, fixed at its base, the branches supporting at their ends numerous bodies, a little larger than the pedicles, each resembling an *Actinophrys.*

D. radians. Bodies conical, thick, soft and smooth, alternately branched; branches incrassate and tentaculate at the ends. Size 1-96″. Aquatic.

BIBL. Ehrenberg, *Infus.* p. 316; Cl. & Lachm. *Inf.* iii. p. 140 (fig.).

DENDRYPH'IUM, Wallr.—A genus of Dematiei (Hyphomycetous Fungi), consisting of moulds growing over dead herbaceous plants, nearly related to *Dactylium*; but there are often several spores chained together at the tips of the branches; perhaps not distinct from *Brachycladium*, Corda, whose species of *Dactylium* (fig. 165) are brought under this genus by Fries. British species:

Fig. 165.



Dendryphium fumosum.
Magn. 200 diams.

1. *D. curtum*, Berk. and Br. On dead stems. *Ann. Nat. Hist.* 2 ser. vii. pl. 6. fig. 9.
2. *D. laxum*, Berk. and Br. On dead stems. *L. c.* fig. 10.
3. *D. griseum*, Berk. and Br. On dead stems. *L. c.* fig. 11.

BIBL. Berkeley and Broome, *l. c.* p. 176, pl. 6.; Fries, *Summa Veget.* 504.

DENTALI'NA, D'Orbigny.—The bent, oblique, and somewhat excentric varieties of *Nodosaria* pass under this name for convenience rather than for zoological reasons. Innumerable modifications of these curved and tapering stichostegian Foraminifera occur in all formations from the Carboniferous to the Tertiary, and abound in existing seas. *D. communis*, D'Orb. (Pl. 18. f. 33) is the type, and has persisted the longest of any.

BIBL. D'Orb. *For. Foss. Vien.* 1846; Williamson, *Rec. For.* 17; Morris, *Brit. Foss.* 34; Carpenter, *Introd. Foram.* 163; Jones, Parker, and Brady, *Monog. Foram. Crag, Pal. Soc.* 1866, 53, &c.

DENTALINOP'SIS, Reuss.—A stichostegian *Nodosarina*, commencing in its growth as a *Rhabdogonium* (*Orthocerina*), and continuing as a *Dentalina.* Only fossil; Cretaceous.

BIBL. Reuss, *Sitzungsb. Akad. Wien*, xliv. 367.

DENTICEL'LA, Ehr. See BIDDULPHIA.

DENTIC'ULA, Kütz.—A genus of Diatomaceæ.

Char. Frustules free, single or binate, straight, oblong or linear in front view; valves elliptical or narrowed at the ends, transversely striated. Aquatic.

Striæ mostly coarse, not resolvable into dots (costæ); valves without a median line or nodules; ends of the striæ visible at the margins of the front view of the frustules; no internal septa.

Five British species. Seven European species; one fossil (California).

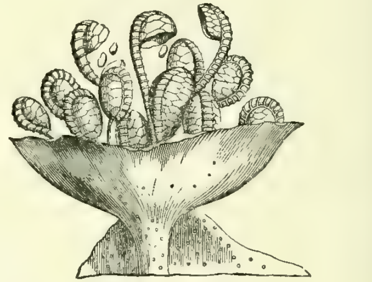
D. obtusa (Pl. 12. fig. 25: *d*, front view; *c*, valve). Valves lanceolate, attenuate and obtuse at the ends; length 1-330″.

The other species differ principally in size; *D. sinuata* is undulate in side view.

BIBL. Kützing, *Sp. Alg.* p. 11; Smith, *Brit. Diat.* ii. 19; Rabenhorst, *Fl. Alg.* i. p. 114.

DEPA'RIA, Hooker.—A genus of Dicksoniæous Ferns, with stalked indusia shaped like ancient flat goblets (fig. 166). Exotic.

Fig. 166.



Deparia prolifera.
Sorus enclosed in the stalked indusium.
Magnified 25 diameters.

DEPA'ZEA, Fries. See SPHÆRIA.

DEPOSITS, URINARY. See URINE.

DERMANYS'SUS, Dugès.—A genus of Arachnida, of the order Acarina, and family Gamasea.

Char. Body mostly soft; palpi, the fifth (last) joint smallest; labium acute; mandibles of the male chelate, external claw very long; of the female, ensiform; anterior legs longest; coxæ approximate.

D. avium (Pl. 2. fig. 24). Found in the cages of tame singing birds. Body ovate-oblong, depressed, slightly broader and sometimes emarginate posteriorly. The sixth joint of the legs (*c*) is the longest. Mouth forming a kind of moveable head attached to the under part of the anterior margin of the body; it consists of:—1, a triangular labium, pointed in front, and with two palpi; 2, the palpi (fig. 24 *a**), the second joint largest, the fifth smallest and accompanied by a large but short, moveable, external seta; and, 3, the two mandibles (*b*, of female; *a*† of male). Red or reddish brown.

D. vespertilionis. Found upon the mouse-coloured bat (*V. murinus*). Rostrum nearly as long as the palpi, broad or oval at the base, narrowed in front, cleft longitudinally above, and containing the two long and slender mandibles.

D. pipistrelli. On the common bat (*V. pipistrellus*).

D. hirundinis. In the nest of the swallow.

D. gallinæ. On the common fowl.

Other species are found on the noctule bat (*V. noctula*), the merlin, the turkey, the snail, the mouse, serpents, &c.; and two on the pæony and the convolvulus.

Two doubtful species are described as occurring upon the human body, one of them in ulcers.

BIBL. Dugès, *Ann. d. Sc. Nat.* 2 sér. ii. p. 19; Gervais, *Walckenaer's Arachn.* iii. p. 222; Busk, *Micr. Journ.* 1842, ii. p. 65.

DERMATISCUM, Nyl.—A genus of Lichens, tribe Lecanorei, formed to contain *Endocarpon Thunbergii*, a native of the Cape of Good Hope.

BIBL. Nylander, *Enum. Gen.* p. 116.

DERMES'TES, Linn.—A genus of Dermestidæ.

DERMES'TIDÆ.—A family of Coleopterous Insects.

Char. Antennæ short, clavate, not elbowed; labrum very short, with a membranous tip; mandibles short, thick, toothed at the tip, and concealed beneath the labrum; legs partially contractile, the five-jointed tarsi not folded under the tibiæ when at rest, the latter long and narrow; body ovoid or oblong, thick, rounded at each end, and clothed with hairs or scales; head short, deeply immersed in the cavity of the thorax, which is trapezoid and broadest behind.

The larvæ of these insects create great ravages amongst dried skins, furs, &c.; they also feed upon feathers, bacon, books, paper, mummies, &c. They are particularly interesting to the microscopist, on account of the peculiar and beautiful structure of the hairs (Pl. 1. fig. 1) existing upon their bodies.

British gen.: *Anthrenus, Attagenus, Megatoma, Tiresias, Dermestes,* and *Trinodes.*

BIBL. Westwood, *Introd. &c.*; Curtis, *Brit. Insects,* 682; Stephens, *Manual,* p. 142.

DESMARES'TIA, Lamx.—A genus of Sporochnaceæ (Fucoid Algæ), consisting of olive or brownish sea-weeds, with repeatedly pinnate, feathery fronds, from one to several feet long, growing chiefly between tide-marks or in deep water. The characters of the reproductive structures have not yet been made out, as the species rarely fruit on our coast, although the plants are common.

BIBL. Harvey, *Brit. Mar. Alg.* 23, pl. 5 D; *Phyc. Brit.* 49, 115; Greville, *Alg. Brit.* pl. 5. figs. 1 to 6.

DESMIDIA'CEÆ (Pl. 10).—A family of Confervoid Algæ, consisting entirely of microscopic flexible organisms inhabiting fresh water, scarcely a specimen of which can be found that does not contain some of them. They occur in greatest abundance in clear pools in open exposed situations, the larger species being generally found nearest the bottom. Sometimes they adhere in large quantities to aquatic plants, forming green films investing these; at others they rest as a thick coating at the bottom of the water, or lie intermingled with Confervæ, &c.

They are most striking objects under the microscope, from the peculiarity, beauty, and variety of their forms, and their external markings and appendages; that which is most distinctive in their appearance is the bilateral symmetry, indicative of the tendency to divide into two valves or segments. Each frustule is in reality a single cell, as is shown by the fact that the entire contents escape when an orifice is made; but in the generality of the forms, a constriction, or more or less deep notch, or a kind of suture exists in the middle of the external cellulose coat. In a few instances, such as *Scenedesmus,* the symmetrical form is absent; *in Pediastrum* (Pl. 10. figs. 48, 49) it is only indicated by a notch on the outer side; but a graduated series may be formed, from those genera in which this character is inconspi-

cuous, to those in which it is fully developed. Thus in *Closterium* (figs. 40 to 45) and some species of *Penium*, there is no constriction; in *Tetmemorus* (fig. 33), some *Cosmaria* (fig. 22), and *Hyalotheca* (fig. 1), it is quite evident, although but slight; in *Didymoprium* and *Desmidium* (fig. 7), it is denoted by a notch at each angle; while in *Sphærozosma*, *Micrasterias* (fig. 13), and some other genera, the constriction is very deep, the connecting portion forming a mere isthmus between the segments, which appear like distinct cells.

The cells frequently exhibit external warty or spinous processes (Pl. 10. fig. 23), and the cellulose coat (coloured blue by means of iodine and sulphuric acid) presents minute markings which, unlike those on the siliceous envelope of the Diatomaceæ, are always elevations. The cells are surrounded by a more or less perfect and distinct sheath, of gelatinous consistence, and very transparent. In *Hyalotheca, Didymoprium, Sphærozosma*, &c., this is very well defined (Pl. 10. figs. 1 to 6); but in other genera it is more attenuated, and the fact of its existence can only be discovered by its preventing the contact of the cells. The sheath of *Hyalotheca* often presents delicate dark striæ, which, if the gelatinous sheath is not clearly seen, look like rigid cilia standing upon the surface of the cell-wall; these appear to be either fissures in the gelatinous sheath, connected with the breaking up of the filamentous groups into single cells, or they are referable to a fibrous disintegration of the gelatinous sheaths, such as occurs in many OSCILLATORIACEÆ.

The contents of the cells of the Desmidiaceæ appear to be somewhat similar to those of the green Confervoids generally, viz. a mass of protoplasm coloured green by chlorophyll, and entirely enclosed in a primordial utricle, which does not appear to be adherent to the cellulose coat in mature specimens. The contents of the cells contain minute starch-granules in certain stages, as in the other Confervoids, namely in the full-grown condition and in the sporanges formed after conjugation.

It was stated some years ago, by Focke, that the internal surface of the outer coat of *Closterium* is ciliated; and Osborne has declared that the membrane of the endochrome (primordial utricle) is ciliated both on its inner and outer surface. These statements are erroneous, as is shown under CLOSTERIUM.

The Desmidiaceæ, at all events many of them, have the power of fixing themselves to external objects, and possess a feeble power of locomotion, which is not produced by the aid of cilia, and cannot be explained, unless on the principles which have been assumed to account for the same phenomenon in the DIATOMACEÆ. It enables the Desmidiaceæ, when mixed with mud, to make their way to the surface; and they will be found to travel and fix themselves to that side of a glass vessel next the light. In some instances, also, they retire beneath the surface of the mud of pools, &c. before this dries up.

The Desmidiaceæ, like other green plants, evolve oxygen when exposed to the sun's light.

The reproduction of this family exhibits a number of very interesting and varied phenomena. No less than four modes have been observed; and many points connected with the subject still remain to be cleared up.

1. The simplest kind of reproduction is by *cell-division*, where each frustule divides into two. The manner in which this takes place differs to some extent in its details in the various genera, according to the form. Thus in *Closterium* the parent-cell acquires a constricted appearance in the middle, probably not by actual constriction, but by the two halves retreating from each other, while a new hour-glass-shaped prolongation of the membrane is formed in the middle. It appears probable also that the primordial utricle first becomes constricted, since specimens are met with in which this appears divided into two portions in the line of the division. The constriction of the outer cell-wall at length becomes complete, the halves separate, and the truncated new end of each then grows out so as to restore the symmetry of the new frustule. In such forms as *Desmidium, Didymoprium*, &c., the division takes place in a manner apparently resembling that occurring in the filamentous Confervæ. Here there is no necessity for the subsequent restoration of symmetry, as in *Closterium*. In those forms where pairs of globular or elliptical or angular lobes are united by a narrow neck (bipartite forms), the process of division is very curious, and displays itself very clearly. To produce two new symmetrical frustules out of one, it is evident that two new half-frustules must be formed, as in *Closterium*; but in the present cases the foundations of the new halves are laid, and

their development often far advanced, before the division of the parent is completed. The central region of the isthmus expands and displays two globular enlargements, separated from each other, and from each half of the parent, by a neck. These two enlargements are the rudiments of the new 'half-frustules;' and they increase in size (Pl. 10. fig. 11), gradually pushing the halves of the parent-cell apart, until they form two complete half-frustules, back to back, connected by a short neck, at which point they are sooner or later detached from one another. In *Sphærozosma* the cells thus produced remain connected in rows in a gelatinous sheath; and this mode of division is well illustrated by the cells in various stages sometimes seen in such filaments; in *Euastrum, Cosmarium, Staurastrum,* &c., the new cells separate, the old 'half-frustules' taking away each their new 'halves' as new bipartite individuals. The membrane of the nascent 'halves' is very delicate, and at first devoid of the characteristic markings and processes; and it often happens that these are not completely formed before the division is complete. Archer has described some monstrosities of these new halves.

2. A second mode of reproduction has been described by Caspary, and more fully by A. Braun, in *Pediastrum.* The contents of the parent-cells become retracted from their walls, and the whole transformed into a number of active *ciliated zoospores,* which are discharged within a delicate sac from the parent, and after some time come to rest and arrange themselves within this sac (Pl. 6. fig. 11) into a colony having the regular pattern of the species, each zoospore becoming one of the notched frustules of the group (see Pediastrum).

3. A third process, analogous to this, has been observed by Pringsheim in the genus *Cœlastrum* (Nägeli), likewise composed of grouped families: here the contents of each cell are divided into a number of portions, as if for the formation of zoospores (*still zoospores*); but no motion takes place; they acquire cellulose coats, arrange themselves within the parent according to the typical pattern; and then the wall of the parent-cell splits and peels off, leaving them as the foundation of a new group. Connected with this, is a phenomenon which has been observed and figured in *Closterium* by Focke, where the entire green contents were wholly retracted from the walls, and broken up into a number of green encysted globules (Pl. 6. fig. 3 B), closely resembling the thick-walled resting-spores or winter-spores of *Volvox* (Pl. 3. figs. 26, 34), &c.

4. The fourth mode of reproduction is by what is called *Conjugation,* where two cells of a single filament, or of two separate filaments, contract an organic union, their cavities becoming continuous, and their contents becoming blended to form the substance of a spore (*zygospore*). The details of this process will be found under Conjugation and Closterium and other genera of this family; here we have merely to add some observations respecting the sporanges or spores, whichever they may be, formed after conjugation. These are at first cellulose vesicles filled with green and granular contents; by degrees the latter become brown or red, and the coats become thickened. In some genera the coats remain smooth; in others they acquire a granular, tuberculated or even a spinous surface (Pl. 10. fig. 12), these spines being either simple or forked. (Bodies exactly resembling these are found fossil in flint, and are regarded as of the same nature by Ralfs and others; Ehrenberg described them as species of Xanthidium.) The ultimate history of the sporanges is at present obscure. In regard to those of *Closterium* some information exists: both Jenner and Focke describe and figure a globular gelatinous mass, apparently produced from a sporange, in which were imbedded a number of minute frustules (Pl. 6. fig. 3 A, *d*). The observations of Mrs. Thomas also, on *Cosmarium,* should be referred to on this point. The reproduction of the Desmidiaceæ still offers a wide field for investigation.

The Desmidiaceæ may be *collected* in the same manner as is recommended for the Diatomaceæ. Their *preservation* is a somewhat difficult matter, as almost all the preservative liquids alter them more or less. Those producing the smallest amount of change are Thwaites's liquid, Ralfs's liquid, or simple camphor-water. A few of them, for example *Pediastrum,* are unchanged by concentrated solution of chloride of calcium very gradually added, except that the colour becomes rather paler; moreover the cell-membrane, upon the forms of which the characters mainly depend, remains unaltered in all the kinds when kept in this solution. Many prefer glycerine as the preservative medium; and in some cases glycerine-jelly may be used.

See Preservation.

Analysis of the Tribes and Genera. (Pl. 10.)

I. Closterieæ. Cells single, elongated, never spinous, frequently not constricted in the middle (sporangia smooth).

Closterium. Cell crescent-shaped or arcuate, or much attenuated at the ends, not constricted in the middle (figs. 40–45, 57, 58).

Penium. Cell straight, not or very slightly constricted in the middle, rounded at the ends (fig. 36).

Tetmemorus. Cell straight, constricted in the middle, notched at the ends (figs. 33, 34).

Docidium. Cell straight, constricted in the middle, truncate at the ends (figs. 38, 39).

Spirotænia. Cell straight, not constricted; endochrome spiral (fig. 59).

II. Cosmarieæ. Cells single, distinctly constricted in the middle; segments seldom longer than broad (sporangia spinous or tuberculated).

Micrasterias. Lobes of the segments incised or bidentate (fig. 13).

Euastrum. Segments sinuated, generally notched at the ends, and with inflated protuberances (figs. 14 to 17).

Cosmarium. Segments neither notched nor sinuated, end view elliptic, circular, or cruciform (figs. 18 to 22).

Xanthidium. Segments compressed, entire, spinous (figs. 23 to 25).

Arthrodesmus. Segments compressed, each with only two spines (fig. 27).

Staurastrum. End view angular, radiate, or with elongated processes (figs. 26, 28–32, and 56).

III. Desmidieæ. Cells united into an elongated jointed filament (sporangia spherical, smooth).

Genicularia. Filament cylindrical, smooth; endochrome spiral (Pl. 42. fig. 36).

Gonatozygon. Filament cylindrical or fusiform, smooth; endochrome longitudinal, wavy (Pl. 42. fig. 37).

Hyalotheca. Filament cylindrical, cells crenate (Pl. 10. figs. 1, 2).

Didymoprium. Filament cylindrical or subcylindrical; cells with two opposite bidentate projections (figs. 5, 6).

Desmidium. Filament triangular or quadrangular; cells with two opposite bidentate projections (figs. 7, 8).

Aptogonum. Filament triangular or plane, with foramina between the joints (figs. 52, 55).

Sphærozosma. Filament plane, margins deeply incised or sinuated (figs. 9, 10).

IV. Ankistrodesmiæ. Cells elongated, entire, small, grouped in faggot-like bundles.

Ankistrodesmus (fig. 47).

V. Pediastreæ. Cells grouped in the form of a disk or star, or placed side by side in one or two short rows.

Pediastrum. Cells forming a disk or star, marginal cells bidentate (fig. 48).

Monactinus. Cells as in *Pediastrum*, but marginal cells unidentate (Pl. 44. fig. 28).

Scenedesmus. Cells placed side by side in one or two rows (figs. 50, 51, 53, 54).

Three interesting genera are described and figured by Wallich from Lower Bengal (*Leuronema, Onychonema*, and *Streptonema*).

Tetrachastrum, Archer = *Micrasterias*, pt.; *Triploceras* = *Docidium*, pt.; *Leptocystinema*, Arch. = *Gonatozygon*, De Bary; *Spondylosium* = *Sphærozosma*, pt.

Rabenhorst places *Cosmocladium* among the Palmellaceæ.

Bibl. Ralfs, *Brit. Desmid.*; Ehrenberg, *Infus.*; Pritchard, *Infusoria*; Hassall, *Brit. Algæ*; Nägeli, *Einzell. Alg.* Zurich, 1849; Braun, *Verjüng.* (*Ray Soc.* 1853); Focke, *Physiol. Studien*, 1848; Caspary, *Bot. Zeit.* viii. 786 (1850); Pringsheim, *Flora*, 1852, p. 486; Hofmeister, *Ann. Nat. Hist.* 3 ser. i. p. 1; Carter, *ibid.* 2 ser. xvii.; Mrs. Thomas, *Mic. Trans.* 3 ser.; Bailey, *Smiths. Contrib.* 1854; Rabenhorst, *Flor. Alg.* iii. p. 102; Wallich, *Ann. Nat. Hist.* 1860, v. pp. 184, 273; Archer, *Qu. Mic. Jn.* 1860, viii. pp. 85, 215, 235; Brébisson, *Liste &c.* (*Normandie*, 1856, 2 plates).

DESMID'IUM, Ag.—A genus of Desmidiaceæ.

Char. Cells united into a brittle, regularly twisted, triangular or quadrangular filament, and two-toothed at the angles.

The filaments exhibit one or two dark, oblique, wavy lines, arising from their being twisted. In the side view of the cells, the endochrome exhibits thick, frequently cleft rays, corresponding in number with the angles.

1. *D. Swartzii* (Pl. 10. fig. 7; fig. 8, side view of separate cell). Filament triangular. Length of joint 1-2000 to 1-1660″; breadth of filament 1-630″. Not uncommon. Sporangia round or oblong.

2. *D. quadrangulatum.* Filaments quadrangular. Length of joint 1-1240″; breadth of filament 1-600 to 1-450″.

Bibl. Ralfs, *Brit. Desmid.* p. 60; Kützing, *Sp. Alg.* p. 190.

DESMOGONIUM, Ehr.—A genus of Diatomaceæ.

Char. Frustules those of *Synedra* united into tablets, which are coherent by the angles.

D. Kützingii. Submarine marshes; Germany.

D. Gujanense. Found in Asia, Africa, and America.

Bibl. Ehrenberg, *Mikrog.*; Rabenhorst, *Flor. Alg.* i. p. 142.

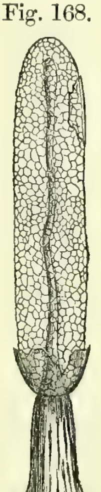
DEUTZ'IA, Thunberg.—A genus of Philadelphaceæ (Dicotyledonous Plants) remarkable for the stellate hairs upon their foliage (Pl. 21. fig. 26), and the reticulated membrane covering the seeds, both of which structures form interesting microscopic objects. See Hairs and Seeds.

Fig. 167.

Diacalpe asplenioides. Part of a pinnule with sori. Magnified 10 diams.

DIACAL'PE, Bl.—A genus of Peranemeæ (Polypodioid Ferns), with globular indusia, splitting open at the top (fig. 167), and containing sporanges inserted on a punctiform receptacle rising from the middle of the vein. Herbaceous; leaves tripinnate, membranous. Native of Java.

Fig. 168.



Diachæa elegans. Magn. 25 diams.

DIACHÆ'A, Fries.—A genus of Myxogastres (Gasteromycetous Fungi), consisting of perishable little plants, growing over either living or dead plants, with an elongated membranous peridium, which falls off like a cap, and displays a white reticulated capillitium furnished with a floccose central column, with interspersed blackish-red spores.

Diachæa differs from *Stemonitis* in the peridium, the columella, and the habit of growth.

D. elegans, Fr. (*Stemonitis*, Trentep.), the only species, has been found in England, upon the living leaves of the Lily of the Valley &c. (fig. 168).

Bibl. Fries, *Syst. Mycol.* iii. p. 155; Berk. *Ann. Nat. Hist.* i. p. 257; Corda, *Ic. Fung.* v. pl. 3. fig. 38.

DIADES'MIS, Kütz.—A genus of Diatomaceæ (Cohort Naviculeæ).

Char. Frustules navicular, closely united into elongated biconvex filaments; valves with a median and terminal nodules. Aquatic and marine.

The markings have not been satisfactorily investigated.

D. confervacea (Pl. 12. fig. 27). Breadth of frustules (in front view) about half the length; valves unstriated (under ordinary illumination), lanceolate, acuminate and acute at the ends; length of frustules 1-960″.

Eight species, some fossil.

Bibl. Kützing, *Sp. Alg.* p. 95; Rabenhorst, *Flor. Alg.* i. p. 259.

DIAMOND-BEETLE. See Curculio.

DIAP'TOMUS, Westw.—A genus of Entomostraca, of the order Copepoda, and family Diaptomidæ.

Char. Head distinct from thorax; inferior antennæ two-branched; thorax and abdomen each of five segments; foot-jaws unbranched; legs five pairs, the first pair with two branches, one three- the other two-jointed; three succeeding pairs with each branch three-jointed; external ovary single, large, lying across the abdomen.

D. castor (Pl. 15. fig. 38). Found in ponds and slowly-running water; common in spring and autumn. Length about 1-8″.

Bibl. Westwood, *Entomologist's Text-book*; Baird, *Brit. Entom.*; M.-Edwards, *Hist. Nat. Crust.* iii. 427.

DIAS, *Lillj.*—A genus of Entomostraca, order Copepoda.

D. longiremis. Cumberland.

Bibl. Brady, *Trans. Northumberland &c.*

DIASTO'PORA, Lamouroux.—A genus of Infundibulate Polyzoa, of the suborder Cyclostomata, and family Tubuliporidæ.

Distinguished by the incrusting, undefined polypidom; and the alternate, tubular, horizontal, immersed cells, with a raised circular orifice.

D. obelia. Crust thin, closely adnate.

Bibl. Johnston, *Brit. Zooph.* 276; Gosse, *Mar. Zool.* ii. 8.

DIA'TOMA, Dec.—A genus of Diatomaceæ (Cohort Fragilariæ).

Char. Frustules (in front view) linear, sometimes cuneate; at first united into flat filaments, afterwards partly separating so as to remain connected by the generally

alternate angles only, and thus forming a zigzag chain.

Filaments either free or fixed by a stipes. Frustules prismatic, without vittæ; valves with transverse continuous striæ (costæ) and intermediate finer striæ, not always visible by direct light; ends of the striæ extending into the front view.

Five British species:

D. vulgare (Pl. 12. fig. 26: *a*, side view; *b*, front view). Fixed by an inconspicuous stipes; frustules rectangular, oblong; valves elliptical, contracted and obtuse at the ends; striæ evident; length of frustules 1-430″. Aquatic.

D. elongatum. Frustules very slender, slightly attenuated towards the middle; valves linear, evidently striated, tumid and rounded at the ends; length 1-280″. Aquatic.

D. grande. Valves linear, constricted near the rounded ends; costæ evident. Aquatic.

D. hyalinum. Filament of numerous frustules; valves linear-elliptical, ends subacute, striæ obscure. Marine.

D. minimum. Frustules two or three; valves elliptical, ends rounded; striæ obscure. Marine.

Bibl. Ralfs, *Ann. Nat. Hist.* 1843, xi. p. 449; Kützing, *Bacill. & Spec. Alg.* p. 16; Smith, *Brit. Diat.* ii. 38; Rabenhorst, *Fl. Alg.* i.

DIATOMA'CEÆ.—A family of Confervoid Algæ, of very peculiar character, consisting of microscopic brittle organisms, found in almost all fresh, brackish, or salt water; sometimes forming a uniform yellowish-brown layer on the bottom of the water, at others adhering to various water-plants, decaying stems, stones, &c., or scattered between the filaments of Conferveæ &c. They also occur among Mosses, *Oscillatoriæ*, and on damp ground.

The individual cells of the Diatomaceæ are called frustules or testules, and are furnished with an external coat of silica (Cytioderm). This consists of two usually symmetrical portions or valves comparable to those of a bivalve shell, which are in contact at their margins with an intermediate piece (the hoop), variable in breadth, according to age &c. When this is very narrow, it forms a mere junction line, and is called the line of suture; and that aspect of the frustules in which this is turned towards the observer forms the front or front view (primary side, Kützing, secondary side, Rabenh.) (Pl. 11. fig. 7; Pl. 12. figs. 9 *a*, 30 *b*). That aspect of the frustules in which the surface of the valves is turned towards the observer, forms the side or side view of the frustule (secondary side, Kütz., primary side, Rabenh.) (Pl. 11. fig. 6; Pl. 12. fig. 30 *a*).

The separate valves are of various forms, circular, oblong, elliptical, linear, saddle-shaped, boat-shaped (navicular), undulate, sigmoid, &c. (Pls. 11, 12, 13); and their surfaces exhibit various more or less delicate sculpturings and markings, in the form of bands, lines either parallel, radiate, or crossing each other, and dots, or a cellular (areolate) appearance.

These markings are in general not well seen, and in some cases cannot be seen at all, until the valves have been properly prepared. They are of special interest, not only on account of their extremely beautiful delicacy and symmetry, but because they are used as tests for the quality of the object-glasses in regard to angular aperture. The nature of the markings is described under the individual genera. The modes of viewing them will be spoken of further on.

In some the hoop is a simple filament, so curved or bent as to assume the form of the section of the frustules, or the edges of the valves (Pl. 11. fig. 11). In others, it is broad, and marked like the surfaces of the valves (Pl. 13. fig. 2 *a*). In others, again, the hoops are numerous, flat, and arranged like the leaves of a book, each with a round or oval aperture in the middle, so that the cavity of the frustules is divided into loculi; these frustules we shall distinguish as compound (Pl. 43. fig. 69).

During the process of multiplication by division, which is almost always going on, the annular, siliceous, narrower or broader band, or hoop, undergoes an increase of width, and thus removes the two valves to some distance apart (Pl. 11. figs. 7, 45; Pl. 12. fig. 1). Sometimes it consists of two pieces, one overlapping the other. Some of the valves are furnished with processes, called cornua or tubuli (Pl. 12. fig. 30 *b*); the surfaces of others are undulate, producing the appearance of dark curved or wavy lines or bands (Pl. 12. figs. 22, 23, 24); sometimes curiously arranged lines (vittæ) indicate either imperfect internal septa, the internal margins of the flattened hoops, or certain inflections of the margins of the valves (Pl. 1. figs. 14, 15; Pl. 13. figs. 17, 18).

In the young state of these organisms, the endochrome (Cytioplasma) is uniformly distributed; but after a certain time the colouring-matter becomes accumulated into various, usually very regular and often elegant forms, and minute granular globules are formed, transparent vesicles become visible, drops of oil, and vesicles filled with granules, which at first are motionless, but afterwards move about as in the swarming motion of the Algæ. Frequently a considerable nucleus-like body is present in the middle of the frustule (Pl. 11. fig. 33 *a*). As we have seen it, delicate processes were visible arising from it.

The frustules of the Diatomaceæ are sometimes surrounded by a transparent gelatinous sheath, frequently of great delicacy, or contained in gelatinous simple or branched tubes; in some genera they are attached by a stipes or stalk to water-plants &c.

Those Diatomaceæ which are not fixed by a stipes, and especially such as are linear or spindle-shaped, are capable of spontaneous motion; they may be constantly seen slowly moving across the field, or now and then starting somewhat suddenly forwards, moving mostly in the direction of their length, sometimes receding, sometimes performing a rotatory movement on their axis. Those which are contained in numbers in gelatinous tubes, like *Encyonema*, are capable of moving backwards and forwards in these; and Mr. Thwaites described a curious movement of the frustules of *Bacillaria paradoxa*, where the frustules, united in a band, slid backwards and forwards over one another.

The cause of these motions is very obscure. They have been supposed to be produced by the endosmotic changes connected with the nutrition of the organisms; but this is very improbable, otherwise they would be met with frequently in other minute unicellular organisms. No true vibratile cilia have yet been detected upon the Diatomaceæ, although Mr. Thwaites imagined, from the appearance of currents in the water, that they exist on *Bacillaria*. Some are not unfrequently found bearing tufts of or fringed with rigid cilia, like those often seen at the ends of the filaments of *Oscillatoriæ*; these would seem to be formed like the fringes met with in the Desmidiaceæ, by a modification of the gelatinous envelope; they never exhibit motion.

In the foregoing paragraphs the Diatomaceæ have been treated in reference chiefly to their own peculiar characters. We must not, however, pass over the physiological relations of these organisms to other families, nor omit to remark upon the unphilosophical treatment they have received at the hands of systematic naturalists.

In placing the Diatomaceæ among plants, we assume an agreement between the frustule of a Diatomacean and an individual cell of any undoubted vegetable, such as *Protococcus*, and between the series of frustules such as we find in *Fragilaria* (Pl. 12. fig. 33), or *Melosira* (Pl. 13. fig. 5 *a*), and the cellular filament of a *Conferva* or a *Zygnema*. This agreement does undoubtedly exist; and the siliceous shell is really only a result of the incrustation or permeation by silica of a true vegetable cell-membrane, just in the same way as takes place in the epidermis of *Equisetum*. It is not yet ascertained in either case whether the silica is outside or in the substance of the cell-membrane; certainly it is not inside, as that would be incompatible with the known phenomena of division. It may be removed by hydrofluoric acid, leaving the basement-membrane *in situ*; but this proves nothing. The probabilities are that the substance of the membrane is imbued with it. The application of the term "epiderm" to the membrane (Smith) is altogether inadmissible, as there is no homology whatever; and the supposition that the reticulations on the valves of some genera denote a compound cellular tissue is at once without foundation in fact and contrary to what the general character of such organisms would lead us to expect, since we find spores, pollen-grains, the outer walls of epidermal cells, the membranes of the Desmidiaceæ, &c., generally exhibiting patterns of some kind, dependent upon the mode of development of the simple membrane forming their external coat.

The cell-contents of the Diatomaceæ require far more careful study than they have yet received. It is most probable that there exists a layer of protoplasm, forming a primordial utricle, inside the cell-membrane, and enclosing the rest of the contents: the coloured substance constituting the mass of the endochrome appears to be a modification of chlorophyll; it takes a green or greenish-blue tint with sulphuric acid, and also often by drying; and H. L. Smith has shown that it exhibits the spectroscopic reactions of chlorophyll. Oil-globules, soluble in ether, are also found, sometimes of large size, in particular stages of growth, probably

representing here the starch-grains found in other Confervoids, or indeed the oil which occurs in them and other plants in seasons of rest. No starch has been detected in this family. A transparent rounded body is often observed in the centre of the contents, and has been called a nucleus. Schmidt found in *Frustulia salina*, after removing the oil by ether and the protoplasm by potash, a substance identical in composition with the cellulose of Lichens. This was probably derived from the organic matter of the silicified membranes of the frustules.

The ordinary mode of increase of the cells of the Diatomaceæ is, like that of all other vegetable cells, a process of division. In *Melosira*, *Isthmia*, &c. this bears a close resemblance to the process which occurs in *Spirogyra*; and it is only a modified form of the same process that is found in the free Diatomaceæ. It may be briefly described thus:—the primordial utricle, enclosing the contents, divides into two portions, which separate from one another in a plane parallel with the sides of the individual frustules; the two valves of the parent-cell gradually separate from one another, remaining connected by the simultaneous gradual widening of the "hoop." In the space thus afforded, the two segments of contents secrete each a new layer of membrane (ultimately silicified) over the surfaces where they are in contact, which layers of membrane constitute two new half-frustules, back to back, corresponding to and conjoined with the two half-frustules of the parent, to form two new individuals. The history and ultimate fate of the "hoop" seems to be variable. Sometimes it becomes solidly silicified, but not much expanded in breadth, and falls off when the two frustules are complete, allowing them to separate; this is the case in *Gyrosigma*, and probably in all the allied forms; these "hoops" are often to be found in large numbers in the settlings of water in which Diatomaceæ have been kept a long time. Perhaps the most remarkable development of the silicified hoop occurs in *Biddulphia* (Pl. 14. fig. 9), *Isthmia*, and similar forms: the new half-frustules formed inside the "hoop" of these genera slip out from it like the inner tubes from the outer case of a telescope. In *Melosira* (Pl. 6. fig. 8) the hoops appear to keep the new frustules united together for some time.

The development of the stipes to which the frustules of many genera are attached, is at present altogether a mystery.

The only mode of reproduction (besides the division) known certainly to exist in the Diatomaceæ, is one in which the operation of *conjugation* takes place. This has been observed in a number of genera, and presents considerable variation in its details. In *Fragilaria* (Pl. 6. fig. 4) and *Surirella* (Pl. 6. fig. 5) the conjugation takes place between two free frustules lying near together, each of which opens at the suture and extrudes its contents in a mass (probably enclosed in the primordial utricle); the masses of contents coalesce, the whole meanwhile becoming involved in a mass of gelatinous substance. After a while, the body resulting from the conjugation is seen to assume the form of a frustule, of larger size than the parents, which Thwaites, the discoverer, called a *sporangial frustule*. In the majority of cases, however, as in *Eunotia* (Pl. 6. fig. 6), *Gomphonema*, *Cocconema*, &c., the conjugation is double, as is the case in *Closterium lineatum* (CONJUGATION); the contents of the parent-frustules apparently divide into two portions (as if for cell-division) before conjugating; and then there is a collateral conjugation of the two pairs, two sporangial frustules being the result. In *Melosira* (Pl. 6. fig. 8) and *Orthosira* (Pl. 6. fig. 9) the conditions are different, and even more curious, if the received view be correct. The appearances presented seem to indicate that the conjugation takes place between two segments of a frustule which have separated as if for ordinary cell-division, but, instead of forming new half-frustules, have coalesced again and secreted a coat over the entire surface, thus constituting one new independent sporangial frustule of larger size. In *Achnanthes* and *Rhabdonema*, two sporangial frustules are formed after the conjugation of the two halves of one (just-divided) frustule. Probably this is a case of very early division of the conjugation-body. In *Melosira* (Pl. 6. fig. 8) the conjugation-body has been observed to increase by cell-division, and form a new filament of far greater diameter than that to which it owed its birth. The sporangial frustules of the free forms doubtless increase by cell-division in the usual way (see CONJUGATION).

In some cases the first product of the conjugated mass is a siliceous sheath, inside which a new frustule is developed, and

finally set free by dehiscence of the sheath (see NAVICULA).

A great difficulty meets us here. The necessary consequence of the conjugation just described is, that every species in which it occurs must be represented by two forms, one small and the other large, between which a gap exists, over which we have at present no means of bridging, except by supposing that the two new halves formed in cell-division need not always be equal, and that, by a dwindling away through a succession of steps of this kind, the progeny of the sporangial frustules may be reduced to the original size. The size of the frustules is said also to vary with the depth of the sea, in marine species. The effect of all this seems to have been disregarded in systematic treatises on the Diatomaceæ. Some of the book-species appear to produce other book-species by conjugation; according to Focke, *Surirella splendida* produces *S. bifrons*, a very distinct form; and it is not improbable that *S. splendida* is produced by the conjugation of *S. Microcora* (Focke). There is great probability, however, that the observations make by Focke upon the contents of certain species will lead to the discovery of another mode of increase—a reproduction by gonidia, either active or quiescent, such as occurs in the Desmidiaceæ and the other Confervoids. Indeed the contents of the cells of *Melosira* have been observed to display a motion like 'swarming.' Such spores or gonidia discharged from the large 'sporangial' frustules might reproduce the small form, just as the young filaments developed from the zoospores of *Chætophora* &c. are very slender compared with those of full-grown filaments. Focke describes and figures appearances in the contents of the frustules of *Pinnularia viridis*, *Surirella bifrons*, and others, very like what occur occasionally in the cell-contents of *Closterium*, namely encysted globules (Pl. 6. fig. 10) resembling the resting-spores of *Volvox* and the filamentous Confervæ (ŒDOGONIUM), and he considers that such bodies produced in *S. bifrons* may probably reproduce *S. Microcora*. In some of Thwaites's figures of conjugating Diatomaceæ (Pl. 6. fig. 6), there are appearances which would lead to the idea that spores were occasionally produced in this process.

The principal attraction of the Diatomaceæ to microscopists, however, lies at present in the structure of the siliceous coats; and we must devote some considerable space to that part of the subject.

Some remarks upon the method of rendering the markings visible have been made in the INTRODUCTION, p. xxv (*Illumination*); and upon the cause of their becoming visible under proper illumination, in the article ANGULAR APERTURE. The grounds for the belief that most of the markings are depressions have also been mentioned (INTRODUCTION, p. xxxiv, *l.*). Different views of the nature of the markings from those entertained by us have been proposed by other authors; but these appear based upon no kind of evidence whatever, and may be regarded as mere statements without attempt at proof. The last we have met with is that of Schacht, who compares them to the striæ upon the liber-fibres of *Vinca*; it would be difficult to find a more hasty generalization. We shall not dwell upon these debates, but proceed to some further instructions for observing the objects.

Preparation of the valves, to render them as distinct as possible, is essential. This may be effected in two ways:—1. By incinerating them upon a very thin plate of mica or platinum foil over the flame of a spirit-lamp. This is the quickest method; but it has the disadvantages of the valves often becoming semifused or agglutinated to each other by the effects of the heat in the presence of the alkaline salts contained in all organic matters, especially those which are of marine origin. 2. Boiling with strong nitric acid. This is the best method. The water containing the Diatomaceæ is allowed to settle for twenty-four hours, the supernatant liquid poured off, and the deposit dried in a porcelain dish. Strong nitric acid is then added, the whole mixed with a feather or glass brush, and poured into a flask or test-tube and boiled for some time, a portion being removed occasionally with a dip-tube to determine when the valves are perfectly clean. When this is the case, distilled water is added to the mixture, and the whole allowed to settle. The supernatant liquid is then carefully decanted, more water added, and the mixture again allowed to settle, poured off, and these operations repeated until a drop of the liquid containing the valves, when evaporated on a slide, leaves no film (of calcareous salts) at the margins of the drop. This is a somewhat tedious process; but it is essential that it should be thoroughly carried out. If the valves be not thoroughly washed, the film

of nitrate of lime remaining upon the slide will absorb water from the atmosphere, and the whole will be spoiled.

The appearance of the valves thus prepared will vary according to their structure, and the manner in which they are examined. In some cases the valves appear colourless, and the markings perfectly distinct with the ordinary direct light of the mirror, provided the power be sufficient (Pl. 13. figs. 2, 29; Pl. 42. fig. 1). In others (Pl. 11), the valves appear coloured when viewed by the ordinary light. But when the mirror is brought to one side, and the light is thus thrown upon the object obliquely, one or two sets of fine parallel black lines are seen traversing the valves (Pl. 1. figs. 17, 18; Pl. 11. figs. 10, 12, 15, &c.). And when an object-glass of considerable aperture is used, with the condenser and central stop exactly centrical (INTRODUCTION, p. xvii), the lines are replaced entirely or in part by a series of black dots (Pl. 1. fig. 16; Pl. 11. figs. 39, 40, &c.); these, under a high eyepiece, have distinctly angular forms, sometimes appearing regularly hexagonal (Pl. 11. fig. 41). If the condenser and stop be not exactly centrical, or the surface of the valve be not flat, the appearance of dark dots will be replaced by that of a set of brilliant pearls (Pl. 11. fig. 46), which many observers consider to represent little hemispherical elevations on the surface of the valves; or the true form of the dark dots will be replaced by some other: thus hexagonal dots may be made to appear triangular, quadrangular, &c., and those dots which cannot be conceived to be really hexagonal (Pl. 11. fig. 39) may be made to appear so.

There can be little doubt that the valves of all the Diatomaceæ are furnished with markings, although in some of them they have not yet been detected. In the most difficultly resolvable of those at present known, lines only can be rendered evident, although these probably consist of rows of dots; these very difficult valves require the use of an Amici's prism (INTRODUCTION, p. xviii), or Powell's latest modified Gillett's condenser.

The recently introduced immersion-lenses or object-glasses are eminently serviceable in resolving the markings upon these difficult objects.

We have already stated (INTRODUCTION, p. xxxiv, *l.*) that we believe the dots to consist of depressions. In reviewing the considerations establishing this point, we may divide the valves into those which exhibit the dots by ordinary light, and those which require oblique light and the use of stops.

In those visible with ordinary light (Pl. 13. fig. 29; Pl. 42. fig. 1, &c.), the valves are thinner and weaker at the parts occupied by the dots, so that the line of fracture corresponds to these parts; and the depressions are distinctly visible at the edges of the curved portions of the valves (Pl. 13. fig. 2 *b*). In those requiring the use of oblique light and stops, the line of fracture also corresponds to the rows of dots, provided the light be equally oblique on all sides; and the same appearances are presented by the dots in both cases, beginning with those in which they are very large (as in *Isthmia*), to those of moderate and small size (as in the species of *Coscinodiscus*), down to those in which they are extremely minute (as in *Gyrosigma* &c.). Moreover, analogy affords a strong confirmatory ground: for the Diatomaceæ form a very natural family; and if the dots are depressions in some genera, we might expect them to be so in the others.

The explanation of the manner in which oblique light renders the dots visible, has been given under ANGULAR APERTURE.

The method of determining the structure of the frustules of the Diatomaceæ is the same as that of microscopic bodies in general, and has been laid down in the INTRODUCTION, p. xxxiv. The presence or absence of a gelatinous envelope or a stipes should first be decided. The general form of the frustules, both in the front and side view, is next examined, which should be done while they are immersed in water,—the frustules being made to roll over by gently moving the glass cover with the point of the mounted needle, the eye being kept upon the object, and a somewhat low power used. The frustules should then be prepared, and examined when dry as to their markings. Perhaps these may be visible by ordinary light; if not, the mirror should be turned on one side as much as possible, to obtain the effects of oblique light. If lines then become visible, it does not follow that the valves are marked with lined structures such as grooves or ridges, because the shadows of rows of dots may become extended into lines under oblique illumination in any direction in which the dots will form a linear series. This point must, however, be decided by examination with the aid of the condenser, stops, &c.

and if the valve be much curved, it must be crushed, so as to obtain a fragment as flat as possible. The markings upon the most difficult valves can only be brought out by using extremely oblique light, reflected either from the mirror brought as close beneath and as much on one side of the stage as possible, or from Gillett's condenser, or the Amici's prism. The field will then appear black or nearly so, the valve having frequently a bluish appearance,—this extreme obliquity of the rays of light being essential, to allow of one set being thrown out of the field (see ANGULAR APERTURE).

In using very oblique unilateral light, spurious rows of parallel lines are often seen, not only upon the valves of the Diatomaceæ, but upon objects not possessing a lined structure, as many crystals &c. These can only be distinguished from those connected with the presence of dots, by their not being resolvable into dots, their greater coarseness and their variability in number (in a given space) under different kinds of illumination.

If the direction of the lines changes with the variation of the position of the valve to that of the incident light, it may be pretty surely predicted that the lines are spurious, and that the condenser and stops will effect their resolution into dots.

It has been remarked above that many recent authors consider the markings or bright pearl-like dots, which so easily run into bright lines at the margins, or when the surface is not flat, represent hemispherical elevations instead of depressions. This view seems founded upon two points—that they look like raised dots or pearls, and that when examined by "Welcker's test" they correspond to raised and not depressed parts. The first point is unworthy of consideration. To call the process described in INTRODUCTION, p. xxxiii, *f*, "Welcker's test" is absurd; it was first proposed by the acute Dujardin in 1842; and great stress was laid upon it by us in 1855, while Welcker's paper appeared long after. It has been stated in the INTRODUCTION that this test is of doubtful value when oblique light is used; for, with this, any opaque particles can be proved to be transparent spherules.

The prepared valves of the Diatomaceæ frequently appear coloured when dry, the colour vanishing when they are moistened. This colour arises from iridescence, and not from the presence of pigment or other colouring-matter (INTRODUCTION, p. xxxi, 3).

Collection. In collecting the Diatomaceæ, a number of phials (1- to 2-oz.), with wide mouths and furnished with corks, must be provided, in which they may be brought home. The mouth of the bottle being closed with the thumb and brought as closely as possible to the masses of them in the water, on removing the thumb, the water will enter and carry the Diatomaceæ with it into the bottle. A spoon is frequently of use in removing layers of them from the bottom of the water, or from pieces of woodwork, &c. immersed in the water. Many of them are entangled in the meshes of Confervæ and other Algæ, or on the submersed stems of the higher plants; these, if fixed to the stems, can only be removed with them; if, however, the masses of Diatomaceæ are merely entangled in the meshes of their stems, they may be detached and collected in the "ring-net" (INTRODUCTION, p. xxv), and the pieces of muslin placed in the bottles. A stick with a loop of string at the end, is often useful in procuring those which would be otherwise beyond reach: the neck of the bottle being engaged in the loop, and the mouth kept downwards when immersed in the water until opposite and close to the masses of Diatomaceæ, it is then inclined upwards and filled. On exposing the bottles to the light for some hours, the Diatomaceæ will collect on the surface of the mud or other matters, and can then be removed with a dipping-tube. It is often difficult to free them from minute particles of sand; this may, however, generally be done by diffusing the deposit through distilled water, allowing the mixture to stand for a short time, and then pouring off the uppermost portions; the sand being the heaviest, will subside first. The deep-sea species may be obtained by dredging, or by treating the alimentary canal of fishes, mollusca, &c. with strong nitric acid as above directed.

The Diatomaceæ are often found fossil; occurring in vast numbers in aquatic and marine geological deposits, forming hills, rocks, and various strata; also in peat-beds, fossil polishing powders, as tripoli, berg-mehl, &c. The deposits from Franzenbad, Bilin, Richmond (U.S.), San Fiore (Tuscany), Bermuda, Lough Morne (Ireland), &c., are well known as containing many of the most beautiful species, and are sold by the dealers in microscopic objects and apparatus. Most of the curious forms, not known to occur

in Britain, may be obtained from Peruvian guano.

The masses sometimes require to be disintegrated by placing lumps in a test-tube, covering them with *Liquor Potassæ*, boiling for a short time until the whole breaks up into a mud, and then instantly pouring it into a quantity of distilled water, and well washing.

Preservation. The Diatomaceæ may be preserved either in the dry state, immersed in balsam, in water, or dilute spirit (one to six) (PRESERVATION). For exhibiting the delicate markings, they should be mounted in the dry state, placed upon and covered by the thinnest glass which can be obtained.

The mounted sable-hair or bristle will be essential in isolating single valves (INTRODUCTION, p. xxiii) for mounting.

With regard to the systematic arrangement of the Diatomaceæ, it appears impossible at present to divide them satisfactorily. The structure of the frustules of many genera is imperfectly known and described; and the supposed species have hitherto been viewed rather in relation simply to their differences in form, than to their specific relations.

The following synopsis, however, will serve to aid in comparing the principal genera scattered through the work. In it, we have used fr. to denote the frustules as seen in front view; v. the valves; granular striæ for striæ resolvable into dots, continuous striæ being costæ or canaliculi. Those genera included within brackets are not British, or have been imperfectly described.

Analysis of the Tribes and Genera.

* *Frustules not enveloped in a gelatinous mass, nor in gelatinous tubes.*

Tribe I. *Striatæ.* Frustules usually transversely striate, but neither vittate nor areolate.

† *Valves without a median nodule.*

Cohort 1. EUNOTIEÆ. Fr. arcuate, single or united into a straight filament.

Epithemia. Fr. single or binate, with transverse or slightly radiant striæ, some at least continuous; no terminal nodules; aquatic and marine (Pl. 12. fig. 32).

Eunotia. Fr. single or binate; v. with slightly radiant granular striæ, and terminal nodules; aquatic (Pl. 42. fig. 27).

Himantidium. Fr. as in *Eunotia*, but united into a filament; striæ parallel, transverse; aquatic (Pl. 12. fig. 36).

[*Amphicampa.* Fossil (Pl. 43. figs. 11, 12).]

Coh. 2. MERIDIEÆ. Fr. cuneate, single or united into a curved or spiral band; valves with continuous or granular striæ.

Meridion. Fr. cuneate, united into a spiral band; striæ continuous; aquatic (Pl. 12. fig. 28; Pl. 13. fig. 7).

Eucampia. Fr. united into an arched band; v. punctate; marine (Pl. 41. fig. 10).

[*Oncosphenia.* Fr. single, cuneate, uncinate at the narrow end; striæ granular; aquatic.]

Coh. 3. FRAGILARIEÆ. Fr. quadrilateral, single or united into a filament or chain; v. with continuous or granular striæ.

Diatoma. Fr. linear or rectangular, united by the angles so as to form a zigzag chain; striæ continuous; aquatic and marine (Pl. 12. fig. 26).

Asterionella. Fr. adherent by the adjacent angles into a star-like filament; v. inflated at one or both ends; aquatic (Pl. 43. fig. 14).

Fragilaria. Fr. linear, united into a straight close filament; striæ granular, faint; aquatic and marine (Pl. 12. fig. 33).

Denticula. Fr. linear, single or binate, rarely more united; striæ continuous; aquatic (Pl. 12. fig. 25.)

Odontidium. As *Denticula*, but fr. forming a close filament; aquatic and marine (Pl. 13. fig. 14).

Cymatosira. Frustules united, margin undulate in front view; valves lanceolate, punctate, obtuse, without a longitudinal line (Pl. 42. fig. 35).

Plagiogramma. Frustules quadrangular, free, forming filaments; valves with two transverse median and terminal costæ, the intervals transversely striated (Pl. 42. fig. 41).

Coh. 4. MELOSIREÆ. Fr. cylindrical, disk-shaped, or globose; v. punctate, or often with radiate continuous or granular striæ.

Cyclotella. Fr. disk-shaped, mostly solitary; v. with radiate marginal striæ; aquatic (Pl. 12. figs. 21, 22).

Melosira. Fr. cylindrical or spherical,

united into a filament; v. punctate, or with marginal radiate granular striæ; aquatic and marine (Pl. 13. figs. 5, 6).

Podosira. Fr. united in small numbers, cylindrical or spherical, fixed by a terminal stalk; v. hemispherical, punctate; marine (Pl. 14. fig. 34).

[*Mastogonia.* Fr. single; v. unequal, angular, mammiform, circular at base, without umbilical processes; angles radiating; fossil (Pl. 43. figs. 23 *a, b*, 24, 25).

Pododiscus. Fr. single or united, with a marginal stalk; v. circular, convex (Pl. 13. fig. 16).

Pyxidicula. Fr. single or binate, free or sessile; v. convex; hoop absent?; aquatic and marine (Pl. 19. fig. 13).

Stephanodiscus. Fr. single, disk-shaped; v. circular, equal, punctate or striate, with a fringe of minute marginal teeth; aquatic (Pl. 43. figs. 26, 27, 28, 29).

Stephanogonia. Fr. as in *Mastogonia*, but ends of valves truncate, angular, and spinous; fossil (Pl. 43. fig. 30).

Hercotheca. Fr. single, turgid laterally; v. with marginal free setæ (Pl. 43. fig. 31).

Goniothecium. Fr. single, constricted in the middle, suddenly attenuate and truncate at the ends (hence appearing angular) (Pl. 42. figs. 18–23).]

Coh. 5. SURIRELLEÆ. Fr. single or binate, quadrilateral, oval, or saddle-shaped, sometimes constricted in the middle; v. with transverse or radiating continuous or granular striæ, interrupted in the middle, or with one or more longitudinal rows of puncta; often keeled.

Bacillaria. Fr. prismatic, straight, at first forming a filament; v. with a median longitudinal row of puncta; marine (Pl. 12. fig. 14).

Campylodiscus. Fr. single, free, disk-shaped; v. curved or twisted (saddle-shaped); aquatic and marine (Pl. 12. fig. 16; Pl. 19. fig. 18).

Doryphora. Fr. single, stalked; v. lanceolate or elliptical, with transverse granular striæ (Pl. 12. fig. 29).

Podocystis. Fr. attached, sessile; v. with a median line, transverse continuous, and intermediate granular striæ (Pl. 42. fig. 7).

Nitzschia. Fr. free, single, compressed, usually elongate, straight, curved or sigmoid, with a not-median keel, and one or more longitudinal rows of puncta; aquatic and marine (Pl. 13. figs. 9–13).

Cymatopleura (*Sphinctocystis*). Fr. free, single, linear, with undulate margins; v. oblong or elliptical, sometimes constricted in the middle; aquatic (Pl. 12. figs. 23, 24).

Surirella. Fr. free, single, ovate, elliptical, oblong, cuneate, or broadly linear; v. with a longitudinal median line or clear space, margins winged, and with transverse or slightly radiating continuous striæ; aquatic and marine (Pl. 13. figs. 21, 22).

Synedra. Fr. prismatic, rectangular, or curved; at first attached to a gelatinous lobed cushion, often becoming free; v. linear or lanceolate, usually with a median pseudo-nodule and longitudinal line; aquatic and marine (Pl. 13. figs. 23–25).

Tryblionella. Fr. free, linear or elliptical; v. plane, with a median line, transverse striæ, and submarginal or obsolete alæ; aquatic and marine (Pl. 13. figs. 30–32).

[*Rhaphoneis*=*Doryphora* without a stalk.]

Coh. 6. AMPHIPLEUREÆ. Fr. free, single, straight or slightly sigmoid; v. lanceolate, or linear-lanceolate, with a median longitudinal line.

Amphipleura. Char. as above (Pl. 12. fig. 7 *a, b, c*).

[*Cylindrotheca* (Pl. 42. fig. 34).]

†† *Valves with a median nodule.*

Coh. 7. COCCONEIDÆ. Fr. straight or bent, attached by the end or side; valves elliptical, equilateral.

Cocconeis. Fr. single, compressed, adnate; v. elliptical, one of them with a median line (Pl. 12. figs. 17, 18).

Coh. 8. ACHNANTHEÆ. Fr. bent, stalked at one angle or free; v. with a stauros.

Achnanthes. Fr. compressed, single or rarely united into a straight filament, curved, attached by a stalk at one angle; uppermost valve with a longitudinal median line, lowermost with the same, and a stauros or transverse line; marine (Pl. 12. figs. 1–4).

Achnanthidium. Fr. those of *Achnanthes*, but free; aquatic (Pl. 12. figs. 5, 6).

Cymbosira. Fr. those of *Achnanthes*, solitary or binate, stipitate, and attached end to end; marine (Pl. 14. fig. 18).

Coh. 9. CYMBELLEÆ. Fr. straight or curved, free or stalked at the end; v. inequilateral, not sigmoid.

Cymbella. Fr. free, solitary; v. navicular, with a subcentral and two terminal nodules, and a submedian longitudinal line; aquatic (Pl. 42. fig. 2).

Cocconema. Fr. those of *Cymbella*, but stalked; aquatic (Pl. 12. figs. 19, 20).

Coh. 10. GOMPHONEMEÆ. Fr. wedge-shaped, straight, free or stalked; v. equilateral.

Gomphonema. Fr. single or binate, wedge-shaped, attached by their ends to a stalk; v. with a median line, and a median and terminal nodules; aquatic (Pl. 12. fig. 34).

[*Sphenella.* Fr. free, solitary, wedge-shaped, involute; aquatic (Pl. 14. fig. 19).

Sphenosira. Fr. united into a straight filament; v. wedge-shaped, at one end rounded, suddenly contracted and produced; aquatic (Pl. 13. fig. 26).]

Coh. 11. NAVICULEÆ. Fr. free, straight; v. equilateral, or sometimes sigmoid.

Navicula. Fr. single, free, straight; v. oblong, lanceolate or elliptical, with a median line, a central and two terminal nodules, and transverse or slightly radiant lines resolvable into dots; aquatic, marine and fossil (Pl. 11. figs. 6–9).

(*Stigmaphora.*)

Gyrosigma. Fr. those of *Navicula*, but valves sigmoid; aquatic and marine (Pl. 11. figs. 10–38).

(*Toxonidea.*)

Pinnularia. Fr. those of *Navicula*, but transverse lines continuous and not resolvable into dots; aquatic and marine (Pl. 11. figs. 1–5).

Stauroneis. Fr. those of *Navicula*, but the median nodule replaced by a stauros; aquatic and marine (Pl. 11. figs. 43–45).

Staurosigma. Fr. those of *Stauroneis*, with a sigmoid longitudinal line.

Diadesmis. Fr. those of *Navicula*, united into a straight filament; aquatic (Pl. 12. fig. 27).

Amphiprora. Fr. free, solitary or in pairs, constricted in the middle; v. with a median keel, and a median and terminal nodules, often twisted; marine (Pl. 12. fig. 8).

(*Donkinia.*)

Amphora. Fr. plano-convex, elliptical, oval or oblong, solitary, free or adnate, with a marginal line and a nodule or stauros on the flat side; aquatic and marine (Pl. 12. figs. 10, 11).

Perizonium. Frustules navicular, free, with thickened zones (Pl. 42. fig. 42).

Tribe II. *Vittatæ.* Fr. with vittæ.

† *Valves without a median nodule.*

Coh. 12. LICMOPHOREÆ. Fr. cuneate; vittæ arched.

Licmophora. Fr. cuneate, rounded at the broad end, radiating from a branched stalk; vittæ curved (formed by inflection of the upper margins of the valves); marine (Pl. 13. fig. 3).

Podosphenia. Fr. those of *Licmophora*, but single or in pairs, sessile upon a thick but little branched pedicel; marine (Pl. 13. fig. 17).

Rhipidophora. Fr. those of *Licmophora*, single or in pairs, upon a branched stipes; marine (Pl. 13. fig. 19).

Climacosphenia. Fr. cuneate, rounded at the broad end, divided into loculi by transverse septa or vittæ; marine (Pl. 19. fig. 9).

Coh. 13. STRIATELLEÆ. Fr. tabular or filamentous; vittæ straight (not arched).

Striatella. Fr. compound, stalked at one angle; vittæ longitudinal and continuous; v. elliptic-lanceolate, not striated (ord. illum.); marine (Pl. 13. fig. 20).

Rhabdonema. Fr. as in *Striatella*, but vittæ interrupted, and v. with transverse granular striæ; marine (Pl. 13. fig. 18).

Tetracyclus. Fr. compound, filaments compressed; vittæ alternate, interrupted; v. inflated at the middle; costæ transverse, continuous; aquatic (Pl. 13. fig. 28).

Tabellaria. Fr. united into a filament, subsequently breaking up into a zigzag chain; vittæ interrupted, alternate; v. inflated at the middle and ends; aquatic (Pl. 13. fig. 27).

[*Pleurodesmium.* Fr. tabular, united into a filament, and with a transverse median hyaline band; marine.

Hyalosira. Fr. tabular, fixed by a stalk at one angle; vittæ alternate, interrupted, bifurcate at the end; marine (Pl. 13. fig. 1).

Anaulus. Fr. rectangular, single, com-

pressed, with lateral inflections, giving the valves a ladder-like appearance; marine (Pl. 43. fig. 7).

Biblarium. Fr. as in *Tetracyclus*, but single; fossil (Pl. 41. fig. 39; Pl. 43. figs. 35–48).

Terpsinoe. Fr. tabular, obsoletely stalked, subsequently connected by isthmi; vittæ transverse, short, interrupted and capitate; aquatic and marine (Pl. 19. fig. 10; Pl. 14. fig. 33).

Stylobiblium. Fr. compound; v. circular, sculptured with continuous striæ; fossil (Pl. 43. fig. 50).]

†† *V. with a median apparent (pseudo-) nodule.*

Grammatophora. Fr. at first adnate, afterwards forming a zigzag chain; vittæ two, longitudinal, interrupted at ends, and more or less figured; marine (Pl. 1. figs. 14, 15).

Diatomella. Fr. quadrangular; vittæ two, interrupted in the middle and at each end (Pl. 42. fig. 16).

Tribe III. *Areolatæ.* Valves circular, with cell-like (areolar) markings, visible by ordinary illumination.

Subtribe 1. **Disciformes.** Valves alike, without appendages or processes.

Coh. 14. Coscinodisceæ. Valves circular.

Actinocyclus. Fr. solitary; v. circular, undulate, the raised portions appearing as rays or bands radiating from the centre, which is free from markings; marine and fossil (Pl. 19. fig. 17).

Actinoptychus. Fr. as in *Actinocyclus*, but radiating internal septa, as well as rays; marine and fossil (Pl. 19. fig. 16).

Coscinodiscus. Fr. single; v. circular, areolar all over; marine and fossil (Pl. 42. fig. 1; Pl. 19. figs. 7, 8).

Arachnoidiscus. Fr. single; v. circular, not undulate, with concentric and radiating lines, and intermediate areolæ, absent from the centre (pseudo-nodule); marine and fossil (Pl. 12. fig. 12).

Asterolampra. Fr. single; v. circular, finely areolar, except in the centre and at equidistant clear marginal rays radiating from the centre, which is traversed by radiating dark lines (septa) alternating with the marginal rays; fossil (Pl. 19. fig. 5).

Asteromphalos. As *Asterolampra*, but two of the central dark lines parallel, and the corresponding marginal ray obliterated; fossil (Pl. 19. fig. 2; Pl. 43. fig. 15).

Halionyx. Fr. single; v. circular, without septa, with rays not reaching the centre, and with intermediate shorter rays; between the rays transverse (concentric?) areolar lines; fossil (Pl. 43. fig. 51).

Odontodiscus. Fr. single, lenticular; v. covered with puncta (areolæ) arranged in radiating rows or excentrically curved lines, and with erect marginal teeth; fossil (Pl. 43. fig. 52).

Omphalopelta. As *Actinoptychus*, but upper part of margin of valves with a few erect spines; fossil (Pl. 43. fig. 53).

Symbolophora. Fr. single, disk-shaped; v. with incomplete septa radiating from the solid angular umbilicus, and intermediate bundles of radiating lines; marine and fossil (Pl. 19. fig. 6; Pl. 43. figs. 54, 55, 56).

Systephania. Fr. single; valves circular, areolar, without rays or septa, with a crown of spines or an erect membrane on the outer surface of each valve; fossil (Pl. 43. figs. 57, 58).

Coh. 15. Anguliferæ. Valves angular.

Amphitetras. Fr. at first united, afterwards separating into a zigzag chain, rectangular; v. rectangular, the angles often produced; marine (Pl. 12. fig. 9).

Amphipentas. Fr. solitary; v. pentagonal; fossil (Pl. 19. fig. 11).

Lithodesmium. Fr. united into a straight filament; v. triangular, one side plane, the others undulate; marine (Pl. 13. fig. 4).

Tribe IV. *Appendiculatæ.* Valves with processes or appendages, or with the angles produced or inflated.

Coh. 16. Eupodisceæ. Fr. disk-shaped; v. circular.

Eupodiscus. Fr. single, disk-shaped; v. circular, with tubular or horn-like processes on the surface; aquatic and marine (Pl. 12. figs. 30, 31).

[*Auliscus.* As *Eupodiscus*, but processes obtuse and more solid; fossil (Pl. 43. fig. 60).

Insilella. Fr. single, fusiform; v. equal, with a median turgid ring between them (=terete *Biddulphia*); marine.]

Coh. 17. Biddulphieæ. Fr. flattened; v. elliptical or suborbicular.

Biddulphia. Fr. rectangular, more or less united into a continuous or zigzag filament; the angles inflated or produced into horns; v. convex, centre usually spinous; marine (Pl. 12. fig. 15; Pl. 14. fig. 9).

Isthmia. Fr. rhomboidal or trapezoidal, cohering by one angle; angles produced; marine (Pl. 13. fig. 2).

Chætoceros. Fr. compressed; v. equal, with a long spine or filament on each side; marine (Pl. 41. fig. 47).

Rhizoselenia. Fr. elongate, subcylindrical, marked with transverse or spiral lines, ends oblique or conical, and with one or more terminal bristles; marine (Pl. 41. fig. 46).

Corinna. Fr. united into semicircular bands; angles produced, spiniferous, intermediate portion hemispherical, septate; valves ellipsoid, transversely bicostate, apiculate at each end.

[*Hemiaulus.* Fr. single, compressed, rectangular, angles produced into tubular direct processes, those on one valve longer than those on the other; fossil (Pl. 19. fig. 3).

Syringidium. Fr. single, terete, acuminate at one end, two-horned at the other; marine (Pl. 43. figs. 32, 33).

Periptera. Fr. single, compressed; v. unequal, one simply turgid, the other with marginal wings or spines; fossil (Pl. 43. figs. 66, 67).

Dicladia. Fr. single; v. unequal, one turgid and simple, the other two-horned; fossil (Pl. 43. figs. 61–65).]

Trinacria. Porpeia. Hydrosera (Pl. 42. fig. 40). *Solium. Zygoceros. Glyphodiscus. Attheya* (Pl. 42. fig. 39.)]

Coh. 18. Angulatæ. Valves angular.

Triceratium. Fr. free; v. triangular, each angle with a minute tooth or horn; marine (Pl. 13. fig. 29).

[*Syndendrium.* Fr. single, subquadrangular; v. unequal, slightly turgid, one smooth, the other with numerous median spines or little horns branched at the ends (Pl. 43. fig. 59).]

(Rabenhorst makes the Angulatæ a subfamily of Biddulphieæ; comprising the European genera *Triceratium, Trinacria,* and *Lithodesmium.*)

** *Frustules enveloped in a mass of gelatine, or contained in gelatinous tubes, forming a frond.*

Mastogloia. Frond mammillate; frustules like *Navicula,* but hoops with loculi; aquatic and marine (Pl. 42. fig. 26).

Dickieia. Frond leaf-like; frustules like *Navicula* or *Stauroneis*; marine (Pl. 14. fig. 16).

Berkeleya. Frond rounded at base, filamentous at circumference; frustules navicular; marine (Pl. 14. fig. 8).

Homœocladia. Frond sparingly divided, filiform; frustules like *Nitzschia,* marine (Pl. 14. fig. 15).

Rhaphidoglœa. Frustules those of *Amphipleura,* tufted in radiating gelatinous filaments (Pl. 14. fig. 11).

Colletonema. Frond filamentous, filaments not branched; fr. like *Navicula* or *Gyrosigma*; aquatic.

Schizonema. Frond filamentous, branched; fr. like *Navicula*; marine (Pl. 14. fig. 12).

Encyonema. Frond filamentous, but little branched; fr. like *Cymbella*; aquatic (Pl. 14. fig. 10).

Syncyclia. Fr. those of *Cymbella,* united in circular bands, immersed in an amorphous gelatinous frond; marine (Pl. 14. fig. 14).

Frustulia. Fr. those of *Navicula,* irregularly scattered through an amorphous gelatinous mass; aquatic (Pl. 14. fig. 17).

Micromega. Fr. those of *Navicula,* arranged in rows, in gelatinous tubes, or surrounded by fibres, these being enclosed in a filiform branched frond; marine (Pl. 13. fig. 8).

Many other species are noticed and figured in this work under the genera, which have not been described with sufficient brevity to allow of their being tabulated, or are not well established.

Bibl. Ralfs, *Ann. Nat. Hist.* 1843, xi. p. 447, xii. pp. 104, 271, 346, 457; Thwaites, *Ann. Nat. Hist.* 1847, xix. p. 200, xx. pp. 9, 343; 1848, 2nd ser. i. p. 161; Smith, *Brit. Diatom.*; Bailey, *Silliman's Jn.* xli. xlii.; id. *Ann. N. H.* 1851, viii. p. 157, and *Smithson. Contrib.* 1854; Ehrenberg, *Infus.*; id. *Berl. Abhandl.* 1839, 1840; id. *Berl. Ber. passim*; id. *Mikrogeologie*; Brébisson, *Diatomées*; Kützing, *Bacillar.* and *Species Algarum*; Pritchard, *Infusoria* (*full account of*

species); Braun, *Verjüng.* (*Ray Soc.* 1853); Nägeli, *Einzell. Algen*, p. 9; Focke, *Physiol. Studien*, Heft ii. 1853; Meneghini, *Sull. Animalit.* &c. (*Ray Soc.* 1853); Gregory, *Diat. of the Clyde*, 1857; Smith (*South France*), *Qu. Mic. Jn.* 1855; id. (*Pyrenees*), 1857; Greville, *Qu. Mic. Jn.* 1859 (Californian), pp. 79, 155, 1865 (Hong Kong), p. 1; H. L. Smith, *Ann. Nat. Hist.* 1869, iv. p. 218; Grunow, *Verhandl. d. Zool.-bot. Gesellsch. in Wien*, 1858, '60, '62; Nylander, *Diat. Fenniæ fossil. addit.* 1861; Weisse, *Mikr. Unters. d. Schwarz-Erde* (*Tscherno-Sjom*), 1855; Heiberg, *Consp. Diat. danic.* 1863 (6 pls.); Wenham, *M. Mic. Jn.* ii. p. 158 (*illuminating*); Wallich, *Mic. Tr.* 1860, 129; viii. 36; *Ann. Nat. Hist.* 1863, xi. p. 351; Schultze, *Qu. Mic. Jn.* 1863, p. 120; Norman, *Qu. Mic. Jn.* 1864, 238 (*cleaning*); Antelminelli, *Qu. M. Jn.* 1868, 254 (*reproduct.*); Flögel, *Arch. f. Mik. Anat.* iv. 472; Macdonald, *Ann. N. H.* 1869, iii. 1; Manoury, *Diat.* 1870; Fritsch & Müller, *D. Skulptur* &c. 1870 (*excellent photographs*); Donkin, *Brit. Diat.* 1871; Rabenhorst, *Flor. Alg.* i. (*the most complete treatise extant*); Pfitzer, *Hanstein's Bot. Abh.* 1871, ii.

DIATOMELLA, Grev. *D. Balfouriana*, Gr. = *Grammatophora B.*, Smith (Pl. 42. fig. 16) = *Disiphonia australis*, Ehr.

DICEL'LA, Werneck.—A doubtful genus of Infusoria.

Bibl. Werneck, *Berl. Ber.* 1841, p. 377.

DICHONE'MA, N. ab Es.—A genus of Lichens, tribe Lecanorei, inhabiting tropical America and Polynesia.

D. sericeum consists of a reticulation of Confervoid filaments spreading in an orbicular form, from branches of trees; a curious microscopic object (Leighton).

Bibl. Nees ab Essenb. *N. Acta*, xiii. p. 12.

DI'CHROISM (double colour) is the term applied to the property possessed by many doubly refracting crystalline substances, of exhibiting two colours when light is transmitted through them in different positions. It may be observed under the microscope in crystals of the tourmaline, the acetate of copper, the chloride of palladium, and the oxalate of chromium and potash, or of chromium and ammonia.

Dichroism depends upon the absorption of some of the coloured rays of the polarized light in the passage through the crystal—this absorption varying with the different relative positions of the planes of primitive polarization of these rays to the axis of double refraction of the crystals, so that the two pencils formed by double refraction are differently coloured.

In the acetate of copper, the two colours are deep blue and yellowish green; in the chloride of palladium, they are red and green; in the oxalate of chromium and potash they are blue and green, and in the tourmaline they are not always the same. The variation in colour is entirely independent of the thickness of the crystal.

Bibl. Brewster, *Phil. Trans.* 1819, and *Optics*, p. 353; Herschel, *Encyc. Metrop.* art. *Light*, p. 1064.

DICKIEI'A, Berkeley and Ralfs.—A genus of Diatomaceæ.

Char. Frustules navicular, irregularly scattered through a flat undulate frond or subgelatinous layer, narrowed at the base so as to appear substipitate.

1. *D. ulvoides* (Pl. 14. fig. 16: *a*, frond, nat. size; *b*, portion magnified; *c*, prepared frustule, front view; *d*, valve). Stipes very short, capillary; frond oblong, irregularly lobed or crenulate; frustules oblong, obtuse-angled, truncate at the ends; valves oblong, with a stauros; length of frond 1 to 1½"; of frustules, 1-1000 to 1-720"; marine.

Frond very pale purplish white. Recent frustules with a round colourless spot at each of the four angles (in the front view). Found in shallow pools between high and low-water mark.

2. *D. pinnata.* Frond irregularly divided, or laciniate; v. like *Navicula.* Marine.

Bibl. Berkeley and Ralfs, *Ann. N. Hist.* 1844, xiv. p. 328, and 1851, viii. 204; Kützing, *Bacill.* and *Sp. Alg.* p. 109; Thwaites, *Ann. N. Hist.* 1848, i. p. 171; Smith, *Brit. Diat.* ii. 166.

DICKSO'NIA, L'Héritier.—A genus of Dicksonieæ (Polypodioid Ferns), including fine arborescent species. All exotic.

DICKSO'NIEÆ.—A family of Polypodioid Ferns.

Illustrative genera.

Dicksonia. Valves of the indusium unequal.

Cibotium. Valves of the indusium nearly equal.

Cystodium. True indusium plane, false indusium hood-like, with connivent margins.

Thyrsopteris. Sori semiglobose; indusium cup-like, the sori on a bi- tripinnate fertile leaf destitute of parenchyma, so as to form a thyrse.

Deparia. Sori as in the last, but with the parenchyma of the leaf developed.

DICLA'DIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single; valves unequal, one turgid and simple, the other two-horned, the horns sometimes branched. Marine and fossil.

D. capreolus (Pl. 43. figs. 63, 64); *D. antennata* (Pl. 43. fig. 61); *D. bulbosa* (Pl. 43. fig. 62); *D. clathrata* (Pl. 43. fig. 65).

BIBL. Ehrenb. *Berl. Ber.* 1844, p. 73, and *Mikrogeologie*; Bailey, *Sillim. Jn.* 1856; Greville, *Mic. Trans.* 1865, 56, 98.

DICORY'NE, Allm.—A genus of Hydroid Polypi, fam. Atractylidæ.

D. conferta. On old shells, *Buccinum*, &c.

BIBL. Hincks, *Brit. Zooph.* 105.

DICOTYLE'DONS.—One of the two great divisions of the Angiospermous Flowering Plants, synonymous with the *Exogens* of Decandolle, and opposed to Monocotyledons,—the name being derived from the condition of the embryo prevailing throughout the vast majority of plants included in this assemblage. As in all other natural groups, instances occur wherein the particular character from which the name is derived, the presence of a pair of cotyledons in the embryo, is absent, as in *Orobanche*, &c. (like the Orchidaceæ and other plants among the Monocotyledons); but in these cases the plants agree with Dicotyledons in general in all the rest of the prominent characters, such as the structure of stem, leaves, plan of flower, &c. See VEGETABLE KINGDOM, WOOD, and SEED.

DICRANA'CEÆ.—A family of Apocarpous operculate Mosses, branching by innovations, or with the tops of the fertile branches several times divided. Leaves lanceolate or subulate, channelled-concave, with a nerve mostly dilated and flattened, rarely slender, scarcely cylindrical. The cells prosenchymatous (often mingled with parenchymatous), rarely papillose, mostly empty, often thickened upwards, thereby rounded or elliptical; the basilar cells arranged in a curved manner at the margins of the leaves, distinctly diverse, parenchymatous, lax, thick, large, flat or with a more or less thick and patelliform front, delicate or robust, hyaline, fuscous, brown or purple, ultimately marcescent, mostly very conspicuous (alar cells). Capsule oval or cylindrical, arched or straight, with a subulate operculum. Peristome, if present, purple, teeth trabeculate.

British Genera.

Blindia. Calyptra dimidiate, hood-shaped, peristome wanting or simple, then of sixteen equidistant, lanceolate, distantly articulated, smooth, slender teeth, slightly trabeculate within, purple, cartilaginous. Capsule exannulate.

Dicranum. Calyptra dimidiate. Peristome simple, teeth connate at the base into a more or less emergent membrane, or equidistant and arising below the orifice of the capsule, split more or less deeply, even in some cases to the base, into two or rarely more free arms, purple below, trabeculate-nodose above (figs. 169 & 170).

Fig. 169.

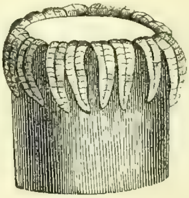
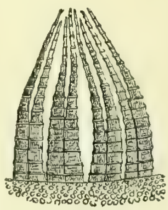


Fig. 170.



Dicranum palustre.

Fig. 169. Mouth of the capsule with the peristome everted. Magnified 40 diameters.

Fig. 170. Portion of the peristome. Magnified 100 diameters.

DI'CRANUM, Hedw.—A genus of Dicranaceæ (Apocarpous operculate Mosses), including numerous British species, very varied in size and habit; some, such as *D. scoparium*, very common (see ÆNGSTRŒMIA and LEUCOBRYUM).

BIBL. Wilson, *Bryol. Brit.* p. 61.

DICTYD'IUM, Schrad.—A genus of Myxogastres (Gasteromycetous Fungi), exceedingly elegant little plants, growing upon rotten wood. The peridium is excessively delicate, and the peculiar capillitium adherent to it; so that, when the spores are expelled, the transparent case appears like a cage, formed of the veins alone. There are no filaments mingled with the spores. *D. umbilicatum* (fig. 171) is a British species; it is of a brownish-purple colour until the spores are discharged, then hyaline; it is gregarious in its habit of growth.

Fig. 171.

Dictydium umbilicatum, Magn. 25 diam.

Bibl. Berk. in Hook. *Brit. Flora*, v. pt. 2. p. 317; Greville, *Sc. Crypt. Fl.* pl. 153; Fries, *Syst. Myc.* iii. p. 164; Schrad. *Nov. Gen.* p. 11, &c.; Corda, *Icon. Fung.* v. pl. 3. fig. 36.

DICTY'OCHA, Ehr.—The nature of the curious bodies, of which the genus *Dictyocha* consists, is unknown. They consist of a single piece; hence they are not Diatomaceæ. This piece is siliceous and loosely reticular or stellate. Marine and fossil.

Kützing enumerates twenty-nine species; distinguished principally by the number of external spines and internal areolæ; they vary in diameter from 1-1150 to 1-370''.

D. gracilis (Pl. 19. fig. 19, perspective view; 20, side view; 21, view from above).

D. fibula (Pl. 42. fig. 19).

Bibl. Ehrenberg, *Berl. Abh.* 1838, and *Mikrogeologie*; Kützing, *Bacill.* and *Sp. Alg.* p. 142; Pritchard, *Infus.* p. 735.

DICTYOGRAMMA. See Sporangiastra.

DICTYOLAMPRA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single; no internal septa; valves equal, cellular (apparently) in the middle, the smooth margin radiate.

D. stella (Pl. 43. fig. 68). The only species. Found among *Polycystina* from Barbadoes.

Bibl. Ehr. *Ber. d. Berl. Akad.* 1847, p. 54.

DICTYOP'TERIS, Presl.—A genus of Polypodieæ (Ferns), deriving their name from the reticulated arrangement of the veins.

DICTYOPYX'IS, Ehr., Grev.—A marine genus of Diatomaceæ.

Char. Frustules areolar, united into short bands; valves convex, cupuliform, hoop absent = *Pyxidicula*, pt.

D. brevis, Grev.; *D. cruciata*, Ehr.

Bibl. Grev. *Mic. Jn.* 1862, 22 (fig.); Ehr. *Berl. Abh.* 1844; Pritchard, *Infus.* p. 825.

DICTYOSI'PHON, Grev.—A genus of Dictyosiphonaceæ (Fucoid Algæ), represented in Britain by a common branched filamentous sea-weed (*D. fœniculaceus*), with the frond growing from one to several feet long, of an olive or rusty-brown colour. The fructification at present known consists of ovoid sporanges, imbedded in the cellular tissue of the branches, lying lengthways; they open by a pore at the surface.

Bibl. Harvey, *Br. Mar. Alg.* p. 40, pl. 7D; Greville, *Alg. Brit.* pl. 8; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 238.

DICTYOSIPHONA'CEÆ.—A family of Fucoideæ. Olive-coloured sea-weeds with cylindrical branched fronds, the *oosporanges* imbedded lengthways in the substance of the frond, opening by a pore on the surface.

British Genera.

1. *Dictyosiphon.* Root a minute naked disk; frond cylindrical, branched; *oosporanges* scattered irregularly, solitary or in dot-like sori.

2. *Striaria.* Root a minute naked disk; frond cylindrical, branched; *oosporanges* arranged in transverse lines on the surface of the frond.

Bibl. See the genera.

DICTYOSPHÆ'RIUM, Näg.—A genus of Palmellaceous Algæ.

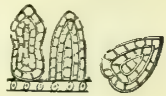
Char. Cells oblong, green, connected by filaments, united into free, rounded, plate-like layers. Aquatic.

2 species: *D. Ehrenbergii* (Pl. 42. fig. 43).

Bibl. Nägeli, *Einzell. Alg.* p. 73; Archer, *Qu. Mic. Jn.* 1866, p. 127.

DICTYOSPOR'IUM, Corda.—A genus of Torulacei (Coniomycetous Fungi) containing one species, *D. elegans* (fig. 172), a minute fungus growing upon oak which has been stripped of its bark; very remarkable for the reticulated character of its spores.

Fig. 172.



Dictyosporium elegans. Spores magnified 1000 diameters.

Bibl. Berk. & Br. *Ann. Nat. Hist.* 2 ser. v. p. 460; Corda, *Icon. Fung.* ii. pl. 8. fig. 29.

DICTYO'TA, Lamx.—A genus of Dictyotaceæ (Fucoid Algæ), containing one British species, *D. dichotoma*, common between tide-marks, on rocks, &c., remarkable for its dichotomously divided membranous frond, of olive-green colour, 3 to 12'' long, which, on distinct individuals, produces three kinds of reproductive organs, viz. 1. *tetraspores*, divided crucially, and either scattered or arranged in sori; 2. *spores* grouped in sori and covered by the common epidermis of the thallus; and 3. *antheridia*, in patches on either face of the thallus.

Bibl. Harvey, *Brit. Alg.* p. 39, pl. 7 Δ; *Phyc. Brit.* pl. 103; Greville, *Alg. Brit.* pl. 10; Thuret, *Ann. des Sc. Nat.* 4 sér. iii. p. 7, pl. 2.

DICTYOTA'CEÆ.—A family of Fucoideæ. Olive-coloured inarticulate sea-weeds,

with large *spores* like those of Fucaceæ, superficial, in definite spots or lines (*sori*), or scattered. Root coated with woolly fibres. Frond flat.

Many other genera are included in this family by most authors; but Thuret has pointed out that the genera here named produce *spores*, while the structures described as such in the others are *oosporanges*. PADINA presents some interesting points of microscopic structure. All the genera are formed of very regular muriform parenchyma.

British Genera.

Haliseris. *Frond* dichotomous, with a midrib.

Padina. *Frond* ribless, fan-shaped, concentrically streaked. *Sori* linear, concentric, bursting through the epidermis.

Zonaria. *Frond* ribless, lobed, concentrically striate. *Sori* roundish, containing spores and jointed threads.

Taonia. *Frond* ribless, irregularly cleft, somewhat fan-shaped. *Sori* linear, concentric, superficial, alternating with scattered spores.

Dictyota. *Frond* ribless, dichotomous. *Sori* roundish, scattered, bursting through the epidermis, or (on distinct individuals) scattered spores.

For other genera often included here, see SPOROCHNACEÆ, PUNCTARIACEÆ, DICTYOSIPHONACEÆ, and CUTLERIACEÆ.

BIBL. See the genera.

DICTYOXYPH'IUM, Hooker.—A genus of Davallieæ (Polypodioid Ferns). Exotic.

DICYE'MA, Köll.—A genus of Infusoria (?), allied to *Opalina*.

D. Mülleri is found in the kidneys &c. of Cephalopoda.

BIBL. Erdl, *Erichs. Arch.* 1843, 162; Kölliker, *Würzburg Ber.* 1849; Clap. and Lachm. *Infus.* ii. p. 201.

DIDER'MA, Pers.—A genus of Myxogastres (Gasteromycetous Fungi), consisting of minute epiphytic plants, of tolerably persistent structure (fig. 173). The peculiar character resides in the double layer of the peridium, the outer being smooth and crust-like, fragile and dehiscent, while the inner is very delicate and evanescent. The species vary in habit, being either stipitate with the stalk more (*Leangium*, Lk.) or less (*Leocarpus*, Lk.) distinct in different cases, and sessile. A dozen species are recorded as British, of which the sessile *D. globosum*, and the obscurely stalked *D. vernicosum*, appear the commonest.

Fig. 173.

Diderma lepidotum.
Magnified 25 diams.

BIBL. Berk. in Hook. *Brit. Fl.* v. pt. 2. p. 310; *Ann. Nat. Hist.* i. 257; *Crypt. Bot.* p. 337; Fries, *Syst. Myc.* iii. 96; *Summa Veg.* 450; Greville, *Sc. Crypt. Fl.* pls. 3, 122 & 132; Corda, *Ic. Fung.*

DIDYM'IUM, Schrad.—A genus of Myxogastres (Gasteromycetous Fungi), consisting of minute plants growing upon leaves, bark, rotten wood, &c. (fig. 174), distinguished by its double peridium, of which, however, the inner membranous layer is the true case (bursting irregularly), while the outer forms a kind of bark, which breaks up into little furfuraceous scales or mealy down. Filaments exist twining among the spores adherent to the peridium. Sixteen species are recorded as British, several of which are not uncommon. They vary in habit, like the *Didermæ*, being either stalked, sessile, or adnate to their support.

Fig. 174.

Didymium hemisphæricum.
Magnified 25 diams.

D. farinaceum is figured by Sowerby as *Trichia sphærocephala*.

BIBL. Berk. Hook. *Br. Fl.* v. pt. 2. p. 312, *Ann Nat. Hist.* i. p. 257, 2 ser. v. p. 365, xiii. p. 459, *Crypt. Botany*, p. 337; Fries, *Syst. Myc.* iii. p. 113; *Summa Veg.* 451; Sowerby, *Fungi*, pls. 12, 240, 412; Corda, *Icon. Fung.*

DIDYMOCHLÆ'NA, Desv.—A genus of Aspidieæ (Polypodioid Ferns), with a curious elliptical indusium opening on each side (figs. 175 & 176). Exotic.

Fig. 175.

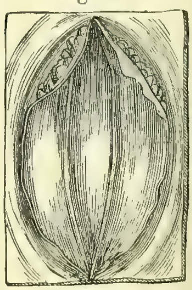
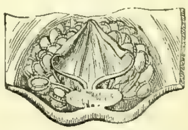


Fig. 176.



Didymochlæna sinuosa.
Fig. 175. A sorus, from above. Magn. 20 diams.
Fig. 176. Transverse vertical section of ditto.

DIDYMO'CLADON, Ralfs.—A genus of Desmidiaceæ.

Char. Cells single, constricted at the

middle, end view tri- or quadrangular; each angle with two processes, one lateral and in the front view nearly parallel with the corresponding one of the other segment, the other superior and divergent.

The two processes distinguish this genus from *Staurastrum.*

D. furcigerus (Pl. 10. fig. 32, front view; fig. 56, end view).

a, end view triangular.

β, end view quadrangular.

Length, including processes, 1-330″.

Bibl. Ralfs, *Brit. Desmid.* p. 144.

DIDYMOHE'LIX, Griffith.—A genus of Oscillatoriaceæ (Confervoid Algæ), with the threads consisting of pairs of microscopic, interlacing, ferruginous, spiral filaments. (Probably surrounded by gelatine.)

D. ferruginea (*Gallionella ferrug.*, Ehr., *Glœotila ochracea*, Kütz.).

Found in ferruginous bog-water.

The structure of the compound filaments of which this beautiful and curious organism consists requires great care to elicit, both on account of their minute size and their peculiar form. The breadth of the filaments is from 1-5000 to 1-30,000″, the average 1-10,000 to 1-20,000″. Filaments imbued with peroxide of iron, containing no silica, or at least not more than a trace, such as is naturally invariably associated with the peroxide. Treated with hydrosulphuret of ammonia, they become black. Acted upon slowly with dilute muriatic acid, the colour gradually vanishes, a very transparent colourless cast of the original being left. If the compound filaments be macerated for some time in distilled water, the filaments will separate (Pl. 1. fig. 10 *d*). Under a ¼-inch object-glass, the filaments present the appearance represented in Pl. 1. fig. 10 *a*. When a higher power is used, they appear as in fig. 10 *b*, which represents them as seen when too much liquid is contained between the slide and the cover, or when the proper correction is not made for the thickness of the glass cover and of the liquid, or when lying edgewise. When lying flat upon the slide, and the correction is perfect, they appear as in Pl. 1. fig. 10 *c*.

In the natural state, a quantity of yellowish-brown gelatinous matter is always found in the water containing the filaments. Ehrenberg supposed that they are formed in or from this. In this ferruginous gelatine are found some fibres of a very minute Nostochaceous plant (probably *Anabaina subtilissima*, Kütz.). *Didymohelix* is by no means common, even in waters which contain a very copious ferruginous deposit. It may be preserved either in the dry state, in chloride of calcium, or in balsam; perhaps the chloride is the best. Balsam renders it very transparent.

We have enumerated this as a test-object for the general excellence of a high-power object-glass, also of the observer's management of the microscope. See Test-Objects.

Bibl. Ehr. *Infus.*; Kütz. *Sp. Alg.* p. 363; Ralfs, *Ann. Nat. Hist.* 1843, xii. p. 351; Grif. *Ann. Nat. Hist.* 1853, xii. p. 438; Rabenhorst, *Hedwigia*, p. 43, pl. 8; Mettenheimer, *Senckenb. Abh.* ii. p. 139.

DIDYMO'PRIUM, Kütz.—A genus of Desmidiaceæ.

Char. Cells with a bidentate or bicrenate process on each side, united into an elongated, fragile, cylindrical, and regularly twisted filament. (Sheath either present, wanting, or indistinct.)

Differs from *Desmidium* in having only two processes, and not being angular, and in the number of rays of the endochrome in the side view not depending upon the number of angles.

D. Borreri (Pl. 1. fig. 11). Joints inflated, barrel-shaped, longer than broad; side view circular; angles bicrenate. (Sheath wanting or indistinct.)

The delicate longitudinal lines were proposed by Jenner as a test-object for the power of the microscope; they are best seen in the empty cells when dried. Breadth of filament 1-1030″.

D. Grevillii (Pl. 10. fig. 5; fig. 6, side view). Joints broader than long, with a thickened border at their junction; side view broadly elliptic; angles bidentate. (Sheath distinct.) Breadth of filament 1-470″.

Bibl. Ralfs, *Brit. Desmid.* p. 55.

DIDYMOSPO'RIUM, Nees.—A genus of Melanconiei (Coniomycetous Fungi), growing upon shoots of trees. The only British species, *D. profusum*, Grev., has very minute, oblong, uniseptate spores, at first glued together like a depressed conical nucleus, beneath the epidermis, afterwards bursting through and becoming free. *D. elevatum*, Lk. = *Melanconium bicolor*, Nees.

Greville's plant, however, has not truly uniseptate spores, and is rather a *Melanconium*, referred as a conidiiferous form by Tulasne to *Melanconis stilbostoma.*

BIBL. Berk. Hook. *Brit. Flor.* v. pt. 2. p. 357; *Ann. Nat. Hist.* 1840, vi. p. 438; Greville, *Sc. Crypt. Fl.* pl. 212. fig. 1 (as *Stilbospora*); Tul. *Carp.* ii. 120.

DIFFLU'GIA, Leclerc.—A genus of Rhizopoda, of the family Arcellina.

Char. Contained in a spherical or oblong, urceolate, incrusted carapace, from the anterior extremity of which are emitted variable numerous or multifid tentacular expansions. Aquatic.

The carapace is membranous, incrusted with minute grains of sand (and carbonate of lime?); in some it is covered with depressions or tubercles; these form the genus *Euglypha*, D. The mode of reproduction has been observed in *D. Enchelys*, which forms gemmæ and also resolves itself into four "spores."

Species very numerous.

D. proteiformis, E. (Pl. 23. fig. 39). Carapace oval or almost spherical, covered with minute grains of sand; length 1-240″.

D. oblonga, E. (*D. globulosa* (?), D.). Carapace oval, oblong, or rounded, smooth, brownish; length 1-200″.

BIBL. Leclerc, *Mém. du Muséum*, ii. 474; Ehr. *Infus.* p. 130; *Berl. Ber.* 1840, &c.; Dujardin, *Infus.* p. 248; Schlumberger, *Ann. d. Sc. Nat.* 1845, iii. 254; Schneider, *Ann. Nat. Hist.* 2nd ser. xiv. p. 332; Clap. & Lachm. *Infus.* p. 447; Lang, *Qu. Mic. Jn.* 1865, p. 285.

DIGLENA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes two, frontal; foot forked.

There are no other appendages than the foot and the rotatory organ.

Nine species.

D. lacustris (Pl. 34. figs. 21, 22). Body oval, transparent, truncate in front; foot suddenly attenuate, somewhat more than 1-4th of the body in length; toes 1-3rd part of the foot in length; aquatic; length 1-70″.

BIBL. Ehr. *Infus.* p. 441; Gosse, *Ann. Nat. Hist.* 1851, viii. p. 200.

DILEP'TUS, Duj.—A genus of Infusoria, fam. Trichodina.

Char. Body fusiform, prolonged anteriorly in the form of a swan's neck, with a lateral mouth at the base of the prolongation; entire surface covered with vibratile cilia, which are more distinct in front and near the mouth.

D. folium, D. (Pl. 23. fig. 40). Body very flexible, in the form of a lanceolate leaf, narrowed in front; with nodular, reticulated, irregular ribs; aquatic; length 1-160 to 1-120″.

D. anser (*Amphileptus anser*, E.).

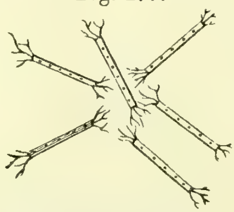
D. margaritifer (*Amphileptus marg.*, E.).

Dujardin separates these species from the genus *Amphileptus*, on account of their not possessing a reticulated integument, and their undergoing diffluence. Cl. & Lachm. unite them with *Amphileptus*.

BIBL. Duj. *Infus.* p. 404.

DILOPHOS'PHORA, Desm.—A genus of Sphæronemei (Coniomycetous Fungi), consisting of *Sphæria*-like plants (without asci), growing upon the leaf-sheaths and glumes of grasses; remarkable for the curiously appendaged spores (fig. 177).

Fig. 177.



Dilophosphora graminis.
Spores. Magnified 800 diams.

D. graminis, Desm. = *Sphæria Alopecuri*, Fries. Sometimes very destructive to wheat crops in the south of England.

BIBL. Desmazières, *Ann. des Sc. Nat.* 2 sér. xiv. p. 4, pl. 1. fig. 2.

DIMEREGRAM'MA, Pritch.—A genus of Diatomaceæ.

Char. Frustules quadrangular, two or more together; valves (undulate, Rab.) with transverse costæ interrupted by a smooth longitudinal line.

Several species.

BIBL. Pritchard, *Infus.* p. 123; Grun., *Wien. Verh.* 1862; Gregory, *Diat. of Clyde*, p. 22; Rabenhorst, *Flor. Alg.* p. 123.

DIMORPHI'NA, D'Orb.—A hyaline Foraminifer, in which the early chambers have the alternate growth of a *Polymorphina*, and the later ones the linear arrangement of a *Nodosaria*. *D. tuberosa*, D'Orb., Modèle no. 60, is the type of this dimorphous *Polymorphina*. Fossil and recent.

BIBL. Parker and Jones, *Ann. N. Hist.* ser. 3. xvi. 28; D'Orb. *For. Foss. Vienne*, 221.

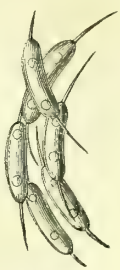
DIMORPHOCOCCUS, Braun.—A genus of Palmellaceous Algæ; consisting of free botryoidal substipitate groups of ovate or lunate green cells, 4 in each.

D. lunatus (Pl. 42. fig. 44). In pools; Germany.

BIBL. Braun, *Alg. Unicell.* p. 44.

DINEMASPO'RIUM, Lév.—A genus of Sphæronemei (Coniomycetous Fungi), consisting of minute plants forming spots upon the leaves of grasses. *D. gramineum*, Lév., the only British species, = *Excipula graminis*, Berk. *Br. Fungi*, No. 328, and *Exc. gram.*, Corda. It has a scattered conceptacle, closed at first, and subsequently widely opened, forming a disk covered with white spores of a peculiar form, abruptly produced into filaments at each end (fig. 178).

Fig. 178.



Dinemasporium gramineum. Spores Magn. 600 diams.

BIBL. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. v. p. 456; Léveillé, *Ann. des Sc. Nat.* 3 sér. v. p. 274; Corda, *Icon. Fung.* iii. pl. 5. fig. 79.

DINEMOU'RA, Latr.—A genus of Crustacea, belonging to the order Siphonostoma and family Pandaridæ.

Char. Lamellar elytriform appendages covering the thorax, only one pair. First three pair of legs setiferous; the posterior foliaceous and membranous.

D. alata and *D. Lamnæ* have both been found upon the Beaumaris Shark (*Lamna monensis*).

BIBL. Baird, *Brit. Entomostr.* p. 282.

DINOBRYI'NA, Ehr.—A family of Infusoria.

Char. Bodies variable in form, contained in urceolate capsules, which are either single, or aggregated into a branched polypidom from the new capsules remaining adherent by their bases to the summits or the bases of the preceding: the result of multiplication by gemmation. (Astasiæa with a carapace.)

Two genera, *Dinobryon* and *Epipyxis.*

In *Dinobryon* an interior red eye-spot is present, but not in *Epipyxis*. In the former a flagelliform filament is present; this is sometimes met with in the latter, but not constantly.

BIBL. Ehr. *Infus.* p. 122; Duj. *Infus.* p. 320.

DINOB'RYON, Ehr.—A genus of Infusoria, of the family Dinobryina.

Char. Carapaces urceolate, united in the form of a branched polypidom.

D. sertularia, E. (Pl. 23. fig. 41). Carapaces sessile or subsessile, slightly constricted near the somewhat expanded and excised end; aquatic; length of polypidom 1-144 to 1-120″, of individuals 1-570″.

Hermann and Archer point out that the individual bodies become encysted at the mouth of the capsules, forming *Chlamydomonas*-like organisms.

Bodies yellow or green, with a red eye-spot in front.

D. sociale, E. Carapace conical, truncate.

D. gracile, E. Carapace slightly constricted in the middle.

The two preceding are probably different stages or mere varieties of the former.

D. petiolatum, D. (Pl. 23. fig. 42). Carapaces with long stalks, bodies green; aquatic; length of polypidom 1-100″, of a carapace 1-1420″.

BIBL. Ehr. *Infus.* p. 124, and *Berl. Ber.* 1840, p. 199; Duj. *Infus.* p. 321; Archer, *Qu. Mic. Jn.* 1866, p. 123.

DINO'CHARIS, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. A single cervical eye; foot forked; carapace closed beneath, and without teeth at the ends.

Jaws with one (or two?) teeth each. Aquatic. Two horns at the base of the foot.

D. tetractis (Pl. 34. fig. 23; fig. 24, teeth). Carapace acutely triangular, two horns at the base of the foot, and two toes; length 1-120″.

Two other species.

BIBL. Ehr. *Infus.* p. 471.

DINO'PHYSIS, Ehr.—A genus of Infusoria, of the family Peridinæa; marine.

Char. Free, single; carapace membranous, urceolate, with a transverse ciliated furrow, and a median plicate crest; no eye-spot.

Form, that of *Vaginicola*; nature, that of *Peridinium*. The transverse furrow is close to the truncated anterior end; and from this furrow there extends down the body a folded crest or fringe, like that of *Stentor*, except that it is a part of the carapace. A crown of cilia exists around the neck, and a longer flagelliform filament. Carapace punctate.

D. norwegica; length 1-420″.

Cl. & Lachm. describe 6 species.

The species are found in sea-water with luminous animals; probably themselves luminous.

BIBL. Ehr. *Berl. Abh.* 1839, pp. 125, 151.

DIO'PHRYS, Duj.—A genus of Infusoria, of the family Plœsconina.

Char. Body of irregular discoidal form, thick, concave above and convex beneath,

with five large vibratile cilia at the anterior, and four or five very long geniculate setæ near the posterior end. Marine.

D. marina (Pl. 23. fig. 43: *a*, under view; *b*, side view). Body oval, with a longitudinal excavation; length 1-580″.

Bibl. Duj. *Infus.* p. 445; Clap. & Lachm. *Inf.* p. 406.

DIPHA'SIA, Agassiz.—A genus of marine Hydroid Polypi, family Sertulariidæ = *Sertularia*, pt.; comprising the species with the ovigerous vesicles cleft at the margin.

7 species.

Bibl. Hincks, *Brit. Zooph.* p. 244.

DIPHYSCIA'CEÆ.—A family of operculate Acrocarpous Mosses, having a capsule of very curious structure. The leaves are of two kinds, the cauline tongue-shaped, composed of perfectly Pottioid, densely hexagonal, parenchymatous cells filled with chlorophyll; the perichætial leaves much protruded, exceeding the cauline, composed of cells ultimately destitute of chlorophyll, therefore of looser texture. Capsule very large, oblique, gibbous, somewhat like that of *Buxbaumia.* Inflorescence monœcious. British genus:

DIPHYS'CIUM, Mohr.—Calyptra conical, covering the operculum. Peristome simple, internal, resembling that of *Buxbaumia*, surrounded at the base by a large, multiplex, soluble annulus.

Bibl. Wilson, *Bryol. Brit.* p. 200; Berkeley, *Handb.* p. 214.

DIPLA'SIUM, Presl.—A genus of Asplenieæ (Polypodioid Ferns). Exotic.

DI'PLAX, Gosse.—A genus of Rotatoria, of the family Euchlanidota.

Char. Those of *Salpina*, except that the eye is wanting, and the carapace (which, as in that genus, is cleft down the back) is destitute of spines both in front and behind; foot and toes long and slender.

Forms a connecting link between *Salpina* and *Dinocharis.*

D. compressa. Carapace in side view forming nearly a parallelogram, greatly compressed; length 1-176″. Aquatic.

D. trigona. Carapace trilateral; surface delicately punctured; length 1-160″. Aquatic.

Bibl. Gosse, *Ann. Nat. Hist.* 1851, viii. p. 201.

DIPLOCO'LON, Näg.—A doubtful genus of Scytonemaceous Algæ.

D. Heppii. On calcareous rocks; Germany.

Bibl. Nägeli, *Nov. Act.* 1857; Rabenhorst, *Fl. Alg.* ii. p. 246 (fig.).

DIPLO'DIA, Fr.—A genus of Sphæronemei (Coniomycetous Fungi), usually growing upon dead twigs &c., bursting through the epidermis. Numerous species have been described as British by Mr. Berkeley; but the resemblance of many to various *Sphæriæ* is remarked by him, and Tulasne states that they are only stylosporous forms of species belonging to that genus or its allies.

Bibl. Berk. *Ann. Nat. Hist.* vi. p. 365, pl. 11. 2 ser. v. p. 371, xiii. p. 459; Hook. *Journal of Botany,* iii. 320, v. p. 40; Léveillé, *Ann. des Sc. Nat.* 3 sér. v. p. 290; Tulasne, *ibid.* xx. p. 136; *ibid.* 4 sér. v. p. 115.

DIPLODON'TUS, Dugès.—A genus of Arachnida, of the order Acarina, and family Hydrachnea.

Char. Mandibles terminated by a straight, acute, and immoveable tooth, to which is opposed a moveable hook or claw; palpi shortish, with the fourth joint longest and terminated by a point as long as the fifth joint; coxæ not very broad, in four separate groups, the posterior of which are semidivergent; a bivalve, granulated, heart-shaped genital plate, the apex directed forwards.

D. scapularis (Pl. 2. fig. 30: fig. *a*, labium with a palp, under view; *b*, a separate mandible more magnified than *a*). Eyes very small, but projecting, wide apart, placed at the anterior rounded angles of the body, blackish and reniform, arising from the fusion of two stemmata. Anterior half of the body black, speckled with a few red spots; posterior half scarlet, but divided by a median longitudinal black band. Length of female 1-10″; male 1-3rd or 1-4th the size of the female.

D. filipes. Palpi much curved downwards, but little visible from above. Body elliptical, depressed, bright red, sometimes marbled with dark brown spots, from the digestive organs being visible through the integument. Eyes four, at the very anterior margin, so best seen from beneath. Integument finely granular, without hairs. Legs red. Length 1-25″.

D. mendax. Two clear longitudinal rays at the fore part of the body.

Bibl. Dugès, *Ann. des Sc. Nat.* 2 sér. i. p. 148.

DIPLONE'IS, Ehr.—A genus of Diatomaceæ = *Navicula* with the valves constricted in the middle, not now retained.

DIPLOZO'ON, Nordm.—A supposed genus of Entozoa, of the family Trematoda. The members have since been shown to consist of two individuals in a state of conjugation.

Char. Body of individuals soft, elongated and flattened, united in pairs by their fusion near the middle, thus resembling an X; each body terminated posteriorly by a transverse, oval, or almost quadrilateral expansion, furnished with four suctorial disks. Mouth terminal, anterior, accompanied by two oblong suctorial disks.

D. paradoxum, the double animal. Found upon the gills of freshwater fishes, as the carp, the roach, the bream, &c. Length 1-6 to 1-5″, or twice this length.

The separate individuals (*Diporpa*, Dujardin) are smaller than those in a state of conjugation (length 1-100 to 1-45″), and contain no trace of reproductive organs. Ova formed in each individual after the conjugation; they are yellow, with the shell narrowed and prolonged into a spiral or coil.

Bibl. Nordmann, *Mikr. Beiträg.* 1832, i. p. 56; *Ann. d. Sc. Nat.* 1833, xxx.; Ehrenberg, *Wiegmann's Archiv*, 1835, ii. p. 128; Mayer, *Beiträg. z. Anat. d. Entoz.* p. 23; Siebold, *Sieb. und Köll. Zeits.* iii. p. 62; Vogt, *Müller's Archiv*, 1841, p. 33.

DIPPING-TUBES. Intr. p. xxii.

DIP'TERA.—The sixth order of Insects, containing the "flies" &c.

DIRI'NA, Fr.—A genus of Lichens, tribe Lecanorei.

D. ceratoniæ (fig. 26, p. 62).

D. repanda. Occurs in Jersey.

Bibl. Leighton, *Lich. Fl. G. B.* p. 235.

DISCELIA'CEÆ.—A family of operculate Acrocarpous Mosses, of gregarious habit, very dwarf and stemless, arising from a green prothallium spreading on the ground. The sheathing leaves are appressed, oblong, acuminate and nerveless, composed of cells lax at the base and apex, rhomboidally parenchymatous, destitute of chlorophyll, fuscescent and empty. The capsule is subglobose and inclined, with a short collum, annulate and long-stalked. The antheridial and archegonial flowers are upon the same runner of the prothallium. British genus:

DISCE'LIUM, Brid.—Calyptra longish, very narrow, split almost to the summit, wider in the middle, with the margin involute on each side at the base. Peristome simple, of sixteen lanceolate teeth, fissile in the middle, trabeculate, striate, cartilaginous, reddish or orange.

Bibl. Wilson, *Bryol. Brit.* p. 286; Berkeley, *Handb.* p. 167.

DISCEL'LA, Berk. and Br.—A genus of Sphæronemei (Coniomycetous Fungi), forming scattered, disk-like, dark spots upon twigs; at first covered by the epidermis, which afterwards splits and separates. Five species are described, occurring on the willow, lime, plane, and elder.

Bibl. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. v. 376, pl. 12. fig. 8; Berkeley, *Outl.* p. 322.

DISCOCEPH'ALUS, E.—A genus of Infusoria, of the family Euplota.

Char. Head distinct from the body; hooks present, but neither styles nor teeth.

D. rotatorius (Pl. 23. fig. 44). Hyaline, flat, rounded at each end; head narrower than the body; length 1-380″. Red Sea. Imperfectly examined.

Bibl. Ehr. *Infus.* p. 375.

DISCOMYCE'TES.—The name of one of the families of Fungi under Fries's classification, including the Helvellacei and Phacidiacei of the Ascomycetes.

DISCOPLE'A, Ehr.—A genus of Diatomaceæ, not now retained, the species being referred to the genera *Cyclotella* and *Coscinodiscus*. Ehr. *Ber. d. Berl. Akad.* 1844, p. 197.

DISCORBI'NA, Parker and Jones.—One of the *Rotalinæ*, having a turbinoid spire, with vesicular chambers, opening one into another by slit-like apertures, which are usually tented over by a succession of umbilical flaps, forming a star-like ornament (see Asterigerina). The shell is usually coarsely, sometimes finely, and occasionally partially porous. Fossil and recent. *D. rosacea* (Pl. 47, fig. 7 *a, b*) is a neat variety of *D. turbo*.

Bibl. Carpenter, *Introd. Foram.* 203.

DISCO'SIA, Libert.—A genus of Sphæronemei (Coniomycetous Fungi), probably related to some of the *Sphæriæ*, as stylosporous forms. The species have been described under various names; and the genus *Phlyctidium* of Notaris is synonymous with it. The British species recorded seem to have been greatly confused by different writers; for *Discosia alnea*, Libert, found on the leaves of alder and beech = *Sphæria artocreas*, Tode, *Xyloma fagineum*, Pers., *Phlyctidium nitidum*, Wallr., *Ph. clypeatum*, Notaris, and, from its name, we conclude also *Dothidea alnea*, Pers. of Hook. *Brit. Flor.*, with its synonyms. Fries, in his *Summa Veget.*, gives *D. artocreas*, *alnea*, and *clypeata* as three distinct species.

BIBL. Léveillé, *Ann. des Sc. Nat.* 3 sér. v. 286; Fries, *Sum. Veget.* 423; Fresenius, *Beitr. z. Mycol.* Heft i. p. 66, pl. 8; De Notaris, *Mem. Accad. d. Torino*, 1849, 2 ser. x.; Berk., Hook. *Brit. Flor.* pp. 278, 288.

DISCOSIRA, Rab.—A genus of Diatomaceæ.

Char. Frustules disk-shaped, concatenate; valves nearly plane, with curved costæ; margin denticulate; centre delicately punctate.

D. sulcata. Italy.

BIBL. Rabenhorst, *Flor. Alg.* i. p. 36.

DISEL'MIS, Duj. = CHLAMIDOMONAS, Ehr. (*Chl. pulvisculus*, E. = *Diselmis viridis*, D.; Pl. 3. fig. 2 *b*, *c*.; Pl. 23. group 30). See PROTOCOCCUS.

Dujardin describes a marine species, *D. marina.* Body almost globular, obtuse, and rounded in front, granular within, and (from generic characters) with a non-contractile tegument and two similar cilia.

He adds to this genus *D. Dunalii* = *Monas Dunalii*, Joly, giving rise to the red colour of the reservoirs of the salt-works of the Mediterranean; oval or oblong, often constricted in the middle; colourless when young, greenish when older, red when adult; no eye-spot.

Probably some marine Algæ.

BIBL. Dujardin, *Infus.* p. 340; Joly, *Hist. d'un Petit Crustacé &c.* 1840.

DISIPHO'NIA, Ehr. *D. australis* = *Diatomella*, pt.

DISO'MA, Ehr.—A genus of Infusoria, of the family Enchelia.

Char. Body double, not ciliated; mouth without teeth, ciliated and truncated (= *Enchelys* with a double body).

D. vacillans (Pl. 23. fig. 45). Segments clavate, filiform; hyaline and narrowed at the anterior end; length 1-380 to 1-288″. In the Red Sea.

BIBL. Ehr. *Infus.* p. 302.

DIS'SODON, Grev. and Arnott.—A genus of Splachnaceæ (Acrocarpous operculate Mosses), including some *Splachna* of authors and a *Cyrtodon*.

BIBL. Wilson, *Bry. Brit.* p. 295; Berkeley, *Handb.* p. 163.

DISTEM'MA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes two, cervical; foot forked.

D. forficula (Pl. 34. fig. 25; fig. 26, teeth). Body cylindrico-conical; eyes red; toes strong, recurved, toothed at the base; aquatic; length 1-120″.

Three other species, two of which are aquatic, and one marine. In the latter, *D. marina*, the cervical eye-spots are colourless; if these do not really represent eyes, this species must be referred to the genus *Pleurotrocha.*

BIBL. Ehr. *Infus.* p. 449.

DISTICHIA'CEÆ.—A family of operculate Acrocarpous (terminal-fruited) Mosses, of cæspitose habit; the stem increasing towards the point, simple or branched; the leaves with a dorsal keel-like nerve, equitant-concave, densely imbricatively overlapping, parenchymatously areolated. Cells minute, with thick walls, somewhat papillose, very densely packed, squarish. Capsules oval, equal. British genus:

DISTIC'HIUM, Br. and Schimper.—Calyptra dimidiate. Capsule annulate. Peristome simple, with sixteen equidistant teeth, free at the base, once or several times slit from the base to the apex, trabeculate, deep purple, homogeneous, smooth or rough. Inflorescence monœcious.

BIBL. Wilson, *Bry. Brit.* p. 104; Berkeley, *Handb.* p. 266.

DISTIG'MA, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. Unattached, eye-spots two, blackish.

There are no cilia, flagelliform filaments, or other locomotive appendages; motion similar to that of a leech. Body variable in form.

D. proteus (Pl. 23. fig. 46 *a*). Body hyaline, obtuse at the ends, alternately contracted or expanded from side to side; eye-spots distinct; aquatic; length 1-570 to 1-430″.

D. viride (Pl. 23. fig. 46 *b*). Body filled with green granules, alternately contracted and expanded; eye-spots distinct; aquatic; length 1-570″.

Two other aquatic species; one yellow, the other colourless.

BIBL. Ehr. *Infus.* p. 116.

DISTO'MA, Gærtn.—A genus of Mollusca, of the order Tunicata, and family Botryllidæ.

Distinguished by the sessile, semicartilaginous, polymorphous mass; the numerous circular systems; the individuals in one or two rows at unequal distances from a common centre, with thorax and stalked abdomen; and the branchial and anal orifices six-rayed. On marine Algæ (*Fucus &c.*).

D. rubrum (Pl. 44. fig. 23). Mass red, individuals yellowish; 5″ in diameter, ½″ thick.

D. variolosum. Reddish- or yellowish-white; bodies orange-red.

BIBL. Forbes and Hanley, *Brit. Moll.* i. 18.

DISTO'MA, Zeder.—A genus of Entozoa, of the order Sterelmintha, and family Trematoda.

Char. Body soft, depressed or cylindrical, more or less elongated, not jointed; furnished with two isolated suckers—one anterior, terminal, and containing the mouth, the other situated on the ventral surface between the middle and the anterior sixth of the body.

Species very numerous; Dujardin describes 164; most common in birds and fishes, generally inhabiting the alimentary canal.

D. hepaticum (the fluke) occurs in the gall-bladder and hepatic ducts of sheep when affected with the 'rot.' It has also been found in the horse, the ox, the goat, the hare, and the stag. Length 4-5 to $1\frac{1}{4}''$.

Some of the other species are microscopic.

BIBL. Dujardin, *Helminth.* p. 381; Beneden, *Ann. d. Sc. Nat.* 3 sér. *Zool.* xvii.; Cobbold, *Linn. Proc.* v., *Linn. Tr.* xxiii. 349.

DIT'IOLA.—A genus of Tremellini (Hymenomycetous Fungi) consisting of saucer-shaped margined gelatinous Fungi, with a discoid hymenium, which is at first veiled. *Ditiola radicata* occurs rarely in this country on decayed firwood. *D. nuda*, B. and Br., is considered by Tulasne synonymous with *Dacrymyces deliquescens.*

BIBL. Alb. & Schwein. pl. 8. f. 6; Berk. *Outl.* p. 291.

DOCID'IUM, Brébisson.—A genus of Desmidiaceæ.

Char. Cells single, straight, much elongated, linear, sometimes attenuated towards the ends; constricted at the middle, ends truncate; segments usually inflated at the base.

Rabenhorst includes the species in *Pleurotænium.*

Docidium, like *Closterium*, has the terminal spaces with moving molecules; and its vesicles are either scattered or arranged in a single longitudinal row.

D. truncatum (Pl. 10. fig. 38). Segments three or four times as long as broad, with a single inflation at the base; suture projecting on each side; length 1-80 to 1-72″.

D. baculum (Pl. 10. fig. 39). Segments very slender, with a single conspicuous inflation at the base, otherwise linear; vesicles in a single series; length 1-111″.

D. nodulosum. Segments four to six times as long as broad, constricted at regular intervals so as to produce an undulated margin; suture projecting; length 1-50″.

Several other species.

BIBL. Ralfs, *Brit. Desmid.* p. 155; Pritchard, *Infus.* p. 744; Rab. *Fl. Alg.* iii. p. 141; Hobson, *Qu. Mic. Jn.* iii. 1863, p. 169 (Bombay).

DOLICHOSPER'MUM, Thwaites (Pl. 4. fig. 2).—A genus of Nostochaceæ, allied to *Trichormus*, *Sphærozyga*, &c., established by Thwaites for five British species, from which Hassall has separated one under the name of *Coniophytum.* Thwaites noticed in this genus that the contents escaped in an undivided mass from the elongated and mostly cylindrical spermatic cells (sporanges), which are invariably truncated at the ends.

D. inæquale, Ralfs. Filaments moniliform; ordinary cells at first quadrate, finally orbicular; vesicular cells large, spherical; sporanges linear, catenate (Ralfs, *Ann. Nat. Hist.* 2 ser. v. pl. 9. fig. 1). Forming extensive strata, composed of thick gelatinous masses of a deep green colour, on boggy pools; filaments consisting of 100 to 200 cells.

D. Ralfsii (Kützing). Filaments moniliform; ordinary cells spherical; vesicular cells elliptic; sporanges elliptic or cylindrical, one or two in each series. Ralfs, *l. c.* pl. 9. fig. 2; *Sphærozyga Ralfsii*, Thwaites, Harvey's *Brit. Algæ*, 2 ed. p. 233. *Cylindrospermum Ralfsii*, Kützing, *Tab. Phycol.* i. pl. 98. fig. 7. Forming extensive strata of a velvety rich dark green colour, sometimes verging towards æruginous green, on rivulets and in bogs.

D. Smithii, Thwaites. Filaments straight, each included in a definite gelatinous sheath; ordinary cells subspherical, compressed, about as long as wide; vesicular cells subspherical, somewhat barrel-shaped, half as wide again as the ordinary cells, puncta very distinct; sporanges cylindrical, very unequal in length, and with the ends rounded and somewhat truncated. Ralfs, *l. c.* pl. 9. fig. 4. Freshwater boggy pools.

D. Thwaitesii, Ralfs. Filaments straight, or nearly so; ordinary cells quadrate; vesicular cells oblong, subquadrate, puncta very distinct; sporanges numerous, cylindrical, with truncated ends, very variable in length (Ralfs, *l. c.* pl. 9. fig. 5). *Sphærozyga Thw.*

Harvey, *Br. Algæ*, 2 ed. 232. Freshwater or brackish pools. (*D. Thompsoni*, Ralfs, see CONIOPHYTUM.)

DONKIN'IA, Ralfs.—A genus of Diatomaceæ = *Amphiprora* with decussating striæ, but without alæ to the valves.

Pritchard describes 7 species. Rabenhorst describes 4 European, and enumerates 12 extra-European species.

BIBL. Pritchard, *Infus.* p. 920; Rabenh. *Flor. Alg.* i. p. 242.

DOO'DIA, R. Brown.—A genus of Asplenieæ (Polypodioid Ferns). Exotic.

DORYPH'ORA, Kütz. — A genus of Diatomaceæ.

Char. Frustules single, stalked; valves orbicular-lanceolate or broadly elliptical, with a median longitudinal line, but no nodules. Marine.

The valves are furnished with transverse or slightly radiating dotted lines.

D. amphiceros, K. (Pl. 12. fig. 29: *a*, side view of frustule; *b*, front view; *c*, prepared valve). Valves orbicular-lanceolate or broadly elliptical, ends produced; length 1-500 to 1-800''.

D. Boeckii, S. (*Cocconema B.*, K.). Valves elongato-lanceolate, ends somewhat obtuse; length 1-144''. (This species appears to have a median and terminal nodules.)

BIBL. Kützing, *Bacill.* p. 74, *Sp. Alg.* p. 50; Smith, *Brit. Diatom.* i. p. 77; Rabenhorst, *Fl. Alg.* i. p. 126 (*Raphoneis*).

DOTHID'EA, Fries.—A genus of Sphæriacei (Ascomycetous Fungi), often growing upon leaves. Distinguished from *Sphæria* and the more closely allied genera by the asci being contained in cavities in the stroma, without any distinct perithecium. Numerous species are described as British by Mr. Berkeley, some of which are now placed under other genera by himself and Fries: thus *D. Geranii*, *Robertiani*, *Ranunculi*, *Potentillæ* and *Alchemillæ* of the *Brit. Flora*, and *D. Chætomium*, Kze., are species of STIGMATEA in the *Summa Veg.*; *D. alnea* is removed to DISCOSIA, and *D. pyrenophora* and *sphæroides* are placed under DOTHIORA, Fries, a stylosporous form. The whole of these plants require further study, since it is probable that they are really connected with the Sphæronemei or Melanconiei; for the observations of Mr. Berkeley go to show that *Asteroma Ulmi* is a form of *Dothidea Ulmi*, while Tulasne has found upon *Dothidea Ribesii* spores or spermatia like those of *Xylariæ*, others in excavated cavities having the character of the spores of *Septoria*, while in ordinary cases the surface is covered with conceptacles filled with eight-spored asci. See CONIOMYCETES.

BIBL. Berk. *Br. Fl.* ii. pt. 2. p. 285; *Ann. Nat. Hist.* vi. 364; Berk. and Br. *Ann. Nat. Hist.* 2 ser. ix. 385; Fries, *Summa Veget.* pp. 386, 418 & 421; Corda, *Ic. Fung.* iv. p. 119; Tulasne, *Ann. des Sc. Nat.* 4 sér. v. p. 118.

DOTHIORA, Fries. See DOTHIDEA.

DOXOCOC'CUS, Ehr.—A genus of Infusoria, of the family Monadina.

Char. No tail; no eye-spot; motion neither that of simple progression nor rotation, but an irregular kind of rolling-over.

Organ of locomotion unknown, Ehr.

D. ruber (Pl. 23. fig. 47 *a*, after Ehr.). Body globose, brick-red, more or less opaque; breadth 1-1728''. Aquatic.

This organism is almost beyond doubt the same as that represented in Pl. 23. fig. 24, *d* and *f* (*nobis*), *i. e.* a form of *Trachelomonas volvocina* (TRACHELOMONAS). This was suspected by Ehrenberg.

D. pulvisculus, E. (Pl. 23. fig. 47 *b*), is probably an early stage of the same.

The other two species—*D. globulus* (subglobose or ovate, hyaline; marine; breadth 1-864''), and *D. inæqualis* (subglobose, unequal, hyaline, speckled with green; aquatic; breadth 1-2400'')—are probably Algæ, or their spores.

BIBL. Ehr. *Infus.* p. 28.

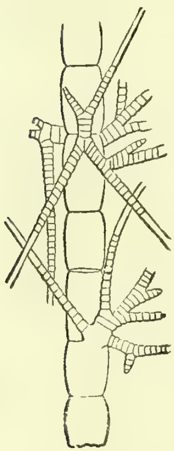
DRAPARNAL'DIA, Bory.—A genus of Chætophoraceæ (Confervoid Algæ), especially distinguished (as limited here in accordance with Kützing) by the filaments being composed of an axis of cells of much greater diameter than that of the tufted cells forming the branches (fig. 179). The species placed here by Hassall and others, devoid of this character, will be found under STIGEOCLONIUM. The green contents of the cells form a broad band in the middle of the cell. These plants are propagated by zoospores formed from the contents of the cells of the branches (fig. 180); the zoospores have four cilia), and by resting-spores formed in the same situation and set free by the solution of the walls.

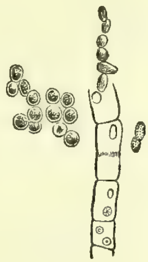
D. glomerata, Ag. (fig. 179). Principal filament about 1-800'' in diameter, irregularly branched; ramelli 1-2400 to 1-3000'', in ovate tufts, generally alternate, and patent. Hassall, *Br. Fr. Alg.* pl. 13. 1; *Engl. Bot.* p. 1746; Vauch. *Conferves*, pl. 12. fig. 1. Common in streams and wells.

D. plumosa, Ag. Principal filaments

somewhat pinnately branched, size about the same as the preceding ramelli in linear-

Fig. 179. Fig. 180.





Draparnaldia glomerata.

Fig. 179. Portion of a filament. Magnified 200 diams.
Fig. 180. Portion of a branch discharging zoospores from its cells. Magn. 400 diams.

lanceolate tufts, mostly approximated to the axis (Vauch. pl. 11. fig. 2; Kützing refers Hassall's *plumosa*, *l. c.* pl. 12. fig. 1, to *D. opposita*, Ag. as doubtful). Common in streams and wells.

D. repetita, Hass. Principal filaments composed of repeated series of cells, each series consisting of five or six cells, diminishing in size from the lowest to the highest, the series adjoining each other obliquely; tufts of ramelli dense, alternate. Hass. *l. c.* pl. 12. fig. 2. Rare.

See STIGEOCLONIUM.

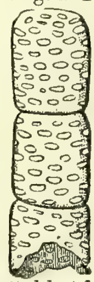
BIBL. Bory, *Ann. du Muséum*, xii.; Vaucher (as *Batrachospermum*), *Conferves d'Eau douce*; Link (as *Charospermum*), *Hor. Phys.* iii.; Hassall, *l. c.* p. 118; Decaisne, *Ann. d. Sc. Nat.* 2 sér. xvii. p. 314; Thuret, *ibid.* 3 sér. xiv. p. 15; Currey, *Qu. Mic. Jn.* vi. p. 207, pl. 9; Hicks, *ibid.* 1869, p. 383.

DRI'MYS, Forst.—A genus of Magnoliaceæ (Dicotyledonous Plants), remarkable for the microscopic structure of the wood. See WINTEREÆ.

DRY ROT.—A peculiar decay in wood, caused either by the presence of Fungi, as *Merulius lacrymans* and *Thelephora pateana*, or by a chemical process known under the name of Eremacausis or gradual combustion. Many remedies have been proposed; sulphate of copper, corrosive sublimate and creosote, especially the latter, are amongst the most approved. In domestic architecture a free circulation of air and exclusion of moisture are essential.

DUCTS.—A term used in structural botany, applied to those forms of the so-called vascular tissue which consist of long tubes constructed out of perpendicular rows of cells, which are thrown into one by the absorption of their adjoining ends. Ducts are thus easily distinguished from vessels (which taper off to closed ends) by the constrictions upon the walls of the tubes, indicating the junctions of the component cells (fig. 181). See TISSUES, VEGETABLE, and VESSELS.

Fig. 181.



Dotted duct from the Melon. Magn. 250 diams.

DUDRESNAI'A, Bonnem.—A genus of Cryptonemiaceæ (Florideous Algæ), containing two minute British species, with delicate, branched, filiform fronds, a few inches high, of rose-red or reddish-brown colour. Both *D. coccinea*, which is a very rare plant, and seldom found except on the south coasts of England and Ireland, and *D. Hudsoni*, a not uncommon sea-weed, present very elegant microscopic structure, the fronds being composed of a central cellular axis, clothed with tufts of delicate, dichotomous, moniliform filaments, standing perpendicularly upon it.

BIBL. Harvey, *Brit. Alg.* p. 154, pl. 21C; *Phyc. Brit.* pls. 110, 244.

DUFOUREA, Ach.—A genus of Lichens. *D. madreporiformis* occurs in Switzerland and Germany.

DUMON'TIA, Lamx.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one British species, *D. filiformis*, having a delicate tubular frond, of yellowish, greenish, or purple colour, of variable length and diameter, with numerous filiform branches, which are long on short fronds, and short on long fronds; growing commonly on rocks &c. between tide-marks. The wall of the tube is composed of a double layer of tissue, the outer of roundish cells, the inner of longish cells forming filamentous rows. The *spores* are attached in clusters to the internal wall of the tube (which is filled up with gelatinous substance), while the tetraspores are found among the surface-cells.

Bibl. Harvey, *Brit. Alg.* p. 147, pl. 20 *a*; *Phyc. Brit.* pl. 59; Greville, *Alg. Brit.* pl. 17.

DYEING.—The dyeing process was introduced by Gerlach, after observing in his carmine-injections, how differently the elements of the tissues were dyed by the colouring-matter.

The general action of the dye is, that the nuclei and the protoplasm of the cells are deeply coloured, while the cell-walls are but little acted upon, and the intercellular substance is hardly at all affected. The cause of this difference in the dyeing effect must lie partly in the physical and partly in the chemical condition of the organic matter.

If the dye-liquor be too strong, or its action too long continued, the whole tissue will become confusedly coloured, and its elements indistinguishable.

Frey recommends that 3 to 6 grains of carmine (better carminic acid?) be dissolved in a few drops of *Liq. Ammon.*, with an ounce of distilled water. To the filtered liquid is added 1 ounce of glycerine, and 2 to 3 drachms of alcohol. This solution may be used alone, diluted with water, or with glycerine. The duration of the maceration will vary according to the kind of tissue and the strength of the dye-liquor; in some cases a few minutes are enough, in others 24 hours are required. The pieces of tissue are then washed with water or a very weak acid (an ounce of distilled water with 2 or 3 drops of acetic acid). Fresh tissues, or those hardened by alcohol are best; next those previously treated with chromic acid or bichromate of potash. Preparations to be preserved in feebly acidified glycerine require to be less dyed than those to be mounted in balsam.

A solution of carmine in borax is sometimes used—4 parts of borax dissolved in 56 parts of water, to which is added 1 part of carmine. The filtered solution is mixed with 2 volumes of alcohol. This solution answers well in dyeing cartilage.

In some cases, indigo-carmine dissolved in aqueous solution of oxalic acid affords beautiful blue preparations.

Many other dyes have been used, such as the aniline colours, the red (Fuchsine), and the aniline blue. Judson's dyes are very powerful, and in many cases useful; also the chloride of gold &c.

With the dyeing liquids must also be mentioned the nitrate of silver, used in dilute solution (1 to 400 or 800 of water). The tissues subjected to this (nuclei of small vessels, epithelium, &c.) should be quite fresh; and usually, long maceration is required. In many cases, the subsequent immersion in solution of chloride of sodium or muriate of ammonia increases the effect, the cellular structure being rendered very distinct, while the intercellular substance is scarcely affected.

But the subject requires thoroughly working out, in regard to the relation of the dye-absorbing power to the chemical composition of the tissue. The process has not been much examined in vegetable tissues—although, so far, the general action seems to be the same.

Bibl. Frey, *D. Mikroskop.*; Beale, *Tiss. of Hum. Body*; Carpenter, *Microscope*; McNab (*Veg.*), *M. M. J.* ii. 154.

DYSTE'RIA, Huxley = *Ervilia.*

DYSTERI'NA, Cl. & Lachm. = *Ervilina.*

DYTIS'CIDÆ.—A family, and

DYTIS'CUS, Linn., or *Dy'ticus*, a genus of Coleopterous Insects, belonging to the family Dytiscidæ.

Characters of the family: antennæ long and slender; external lobe of maxillæ articulated; anterior pair of legs shorter than the posterior pairs, which are flattened and fringed with hairs. Aquatic.

The genus *Dytiscus* is characterized by the first three joints of the anterior tarsi in the male being very large, and expanded into a patella or shield; the didactyle claws; and the maxillary palpi having the second and third joints of equal length.

The species of *Dytiscus* are of large size; *D. marginalis* is common in ponds and pools.

Fig. 182.

Dytiscus latissimus. Natural size.

The head is well adapted for the display

of the trophi, or organs of the mouth. Labrum transverse; mandibles short and robust, with a strong internal tooth; maxillæ short, flat and ciliated internally, with the tip acute, the outer lobe palpiform; the true maxillary palpi about twice as long as the maxillæ; mentum transverse, with the sides produced into two lobes; labium short and square, palpi about twice its length, and three-jointed. The structure of the anterior tarsi in the male is very curious (Pl. 27. fig. 6 *a*), the three basal joints being expanded laterally so as to form a broad and rounded patella or shield, convex above, and covered beneath with a number of suckers or disks of various sizes, some of which are stalked (fig. 6 *b*, a small one). This structure enables the male to retain his hold upon the back of the female, the elytra of the latter being furrowed longitudinally, to aid in this effect. The three basal joints of the tarsi of the middle pair of legs are also flattened beneath, and covered with the stalked disks.

Full-grown larvæ about two inches in length; of a dark ochre or dirty brown colour; the body long, subcylindrical, and eleven-jointed; the two terminal joints long and conical, the sides of the apex fringed with hairs. Terminal segment furnished with a pair of long and slender pilose appendages, by means of which the insect can suspend itself at the surface of the water; these are tubular, and communicate with the tracheæ of the body. Head (Pl. 28. fig. 14) large, oval, or rounded, depressed, and with five or six small elevated tubercles near the anterior angles representing the eyes (fig. 14 *a*). Two rudimentary, slender, seven-jointed antennæ (*b*) are inserted in front of the eyes. The mouth has no aperture; the food, consisting of the juices of the prey, passes through a canal traversing the long, sickle-shaped, acute mandibles (*c*). Maxillæ (*d*) slender, cylindrical, and terminated by a short lateral spine; the maxillary palpi (*e*) are of the same thickness, arising from the tip of the maxillæ, and seven-jointed. The labial palpi (*f*) are slender and four-jointed, the first and third joints being very short.

The head of the larva, and the three pairs of legs of the perfect insect, are commonly mounted as microscopic objects, as are those of other genera belonging to this family—*Acilius* &c.

Bibl. Westwood, *Introd. &c.* i. p. 95; Stephens, *Brit. Beetles.*

E.

ECCRI'NA, Leidy.—See Enterobryus.

ECHINEL'LA, Acharius.—A term applied first to a group of ova of some aquatic animal, next to a genus of Infusoria, more recently to a genus of Diatomaceæ, but now no longer used.

ECHINOBO'TRYUM, Corda.—A doubtful genus of Torulacei (Coniomycetous Fungi). *E. atrum* has been found in Britain, parasitic upon a species of *Pachnocybe.*

Bibl. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. v. p. 460; Corda, *Icon. Fung.* ii. fig. 6.

ECHINOCOC'CUS, Rud.—A supposed genus of Entozoa, of the order Cestoidea and family Cystica; now shown to consist of the larvæ of Tænia.

Char. Consisting of a vesicle of very variable size, sometimes surrounded by a coat of condensed areolar tissue, and containing within, one or more secondary cysts; attached to the walls of these cysts, or suspended in their liquid contents, are numerous oblong, rounded, or oval bodies (scolices), each with four suckers, and a double crown of hooks.

E. veterinorum, the larva of *Tænia echinococcus* (Pl. 16. figs. 1 & 2), occurs in the liver, the cavity of the abdomen, the heart, the voluntary muscles, and the ventricles of the brain of man; in the liver, lungs, &c. of the ox, sheep, goat, ape, pig, &c. Commonly called hydatids. The walls of the brood-cysts consist of numerous concentric layers or plates, resembling those of colloid cells or cysts. The liquid existing within the cysts is yellowish or reddish, albuminous, and frequently contains plates of cholesterine, and crystals of bilifulvine (Pl. 9. fig. 15) (see Bile); some of the latter resemble in form and colour those of Hæmatoidine. The scolices appear to the naked eye as minute, white, opaque specks, varying in size from about the 1-300 to 1-100″ in length. They also vary greatly in form; when the head is retracted (fig. 1 *a*) they appear more rounded than when this is protruded (fig. 1 *c*, 1 *d*, 1 *f*). The hooks surrounding the anterior end of the body (fig. 1 *b*) consist of a broadish basal portion, an internal transverse blunt tooth, and a curved terminal portion or claw; they are about the 1-1500 to 1-1000″ in length. In some of the scolices a kind of pedicle exists at the base, by which they are attached to the wall of the cyst (figs. 1 *a* and 1 *c*); some-

times two or more lines may be perceived, running from the head towards the pedicle, and connected in front by a transverse line —probably representing vessels (fig. 1 *c*). Interspersed through the substance of the body are minute highly refractive corpuscles, containing carbonate of lime.

In the quite recent state, the scolices have been seen swimming actively in the liquid of the cyst; this motion is produced by cilia existing upon the surface of the body. Mingled with the perfect scolices are generally found some in which neither hooks nor suckers are visible, and in which the form is very irregular; some of these assume the natural form when treated with acetic acid.

The scolices appear usually to be developed by gemmation from the interior of the cysts; but, as Kuhn long since showed, they are sometimes produced by external gemmation (fig. 2): the contents produce a slight protrusion of a part of the wall of a cyst; the protruded portion enlarges, afterwards becoming constricted at its base, at last probably separating from the parent, to become itself a parent in the same manner. The example figured in Pl. 16. fig. 2 was not isolated; there were many, contained with numerous other larger cysts, of the most varied sizes, all in one very large parent cyst.

The *Echinococci* do not attain their full development into *Tæniæ*, unless they reach the alimentary canal. The cysts and their contents, including the *Echinococci*, sometimes undergo a kind of degeneration, becoming partially converted into fatty or calcareous matter; or the entire contents become amorphous and granular, the hooks remaining longest unaltered, but finally disappearing also.

BIBL. Kuhn, *Ann. Sc. Nat.* 1 sér. xxix. p. 273; Siebold, *Wiegm. Archiv*, 1845, ii. p. 241, and *Siebold and Kölliker's Zeits.* iv.; Dujardin, *Helminth.* p. 635; Leuckart, *V. d. Hoeven*, *Zool.*, Suppl. p. 85.

ECHINODER'MATA.—A class in the Animal Kingdom, including the star-fishes (*Asterias*), the sea-hedgehogs or sea-eggs (*Echinus*), the sea-slugs (*Holothuria*), &c.

The Echinodermata are marine animals, with a coriaceous or calcareous integument; alimentary canal distinct, suspended in the cavity of the abdomen, and with either one or two orifices; distinct organs of circulation and respiration; sexes not always distinct, and external generative organs never present; disposition of organs generally quinary; body usually radiate or globose, sometimes cylindrical; nervous system forming a ring generally surrounding the mouth and giving off radiate branches.

A cutaneous skeleton usually exists as a network of calcareous corpuscles (Pl. 36. fig. 1), or numerous calcareous plates pretty regularly perforated so as to form a solid continuous network (Pl. 36. fig. 2). The plates are sometimes moveable, at others connected by sutures; some are perforated with larger apertures—the ambulacral pores; they are often furnished with calcareous appendages, tubercles, prickles, spines, hooks, &c., some being imbedded in the leathery integument itself. Many of these appendages, as well as the calcareous corpuscles, form beautiful microscopic objects, and possess very remarkable analytic power (see ECHINUS, SYNAPTA, and SHELL); they are also of importance in classification.

The muscular system consists of distinct flattened primitive fibrils and bundles, not transversely striated. The organs of locomotion exist in the form of little tentacle-like organs, the so-called feet or ambulacra. These are very contractile hollow prolongations of the cutaneous surface, expanded at the end, and connected by the ambulacral pores with contractile sacs (the ambulacral vesicles) placed on the inner surface of the leathery or calcareous covering of the body; they act as organs of adhesion and as feelers.

In the Echinidea (*Echinus*-family) and Asteridea (*Asterias*-family), other curious appendages occur, called *pedicellariæ* (Pl. 36. fig. 3); they are met with all over the cutaneous surface, and consist of a forcipate or valvular apparatus, acting as organs of prehension. The *pedicellariæ* of the Asteridea usually consist of two long forceps-like or two broad valvular arms, and have hence been divided into forcipate and valvate *pedicellariæ*. They are mostly without a stalk. In the Echinidea (*Echinus*) they are most numerous around the mouth, and have been subdivided, according to their form, into :—1. Gemmiform, having three short lentil-shaped arms; 2. Tridactyle, having three long and laterally toothed arms; and 3. Ophiocephalous, with three spoon-shaped laterally toothed arms. These *pedicellariæ* contain a reticular calcareous mass as a basis, and in *Echinus* are placed upon a stalk, the lower portion of which encloses a calcareous nucleus, whilst the

other portions are soft, extensile, and spirally retractile. The *pedicellariæ* of *Echinus*, which are partially covered with ciliated epithelium, can seize larger or smaller bodies, and pass them from one to the other; so that an object grasped by one of them situated on the posterior half of the body, or near the anal region, can gradually pass it on towards the mouth.

The abdominal cavity of the Echinodermata is always filled with sea-water, kept in motion by cilia covering the intestinal canal.

A true blood-vessel system, as well as the water-vessel system, is also present, into the structure of which and other particulars we have no space to enter.

In their youngest state, the Echinodermata consist of infusoria-like beings, without organs, and swimming by means of cilia on the surface. For an account of their subsequent remarkable development, we must refer especially to Huxley's paper, quoted below.

Bibl. Siebold, *Vergl. Anat.* p. 74; *Cycl. Anat. and Phys.* (Sharpey), ii. p. 30; Agassiz, *Echinod. viv. et foss.*; Valentin, *Echinoderm.*; Forbes, *Brit. Starfishes*; Müller and Troschel, *Syst. d. Asteriden*; Müller, *Berl. Abh.* 1846–1851; Huxley, *Ann. Nat. Hist.* 1851, viii. p. 1; Gosse, *Mar. Zool.* i. 54; V. d. Hoeven, *Zool.* and *Suppl.* (Leuckart); Gegenbaur, *Vergl. Anat.* p. 303; Herapath, *Qu. Mic. Jn.* 1865, 175 (*pedicellariæ*); Frey, *Bedeck. wirbell. Th.*; Koren, *Arch. Scandinav.* i. 166, 449; Norman, *Ann. N. H.* 1865, xv. 98; Stewart, *Qu. M. Jn.* 1871.

ECHINORHYN'CHUS, Müller.—A genus of Entozoa, order Acanthocephala.

Char. Body cylindrical or sacciform, somewhat elastic, transversely rugose, obtuse at both ends; furnished with a retractile proboscis, which is armed with from one to sixty regular transverse rows of recurved spines; sexes distinct; no mouth.

The species, which are very numerous, many microscopic, reside in the alimentary canal, most commonly of fishes and reptiles, less so in that of mammals, and still more rarely in that of birds.

E. anthuris (Pl. 16. fig. 35) is very common in newts; *E. proteus* in fish.

Bibl. Dujardin, *Helminth.* p. 483; Leuckart, *Van d. Hoeven's Zool.* (suppl.), p. 93; and *Qu. Mic. Jn.* 1863, p. 56.

ECHI'NUS, Lam.—A genus of Echinodermata, of the family Echinidea.

The species are popularly known as 'sea-urchins,' or 'sea-eggs.'

The beautifully symmetrical structure of their spines, and their curious *pedicellariæ*, afford favourite objects to the admirers of nature's minute wonders. These organs are not confined to this single genus of the family.

See Echinodermata and Shell.

ECTOCARPA'CEÆ.—A family of Fucoideæ. Olive-coloured, articulated, filiform sea-weeds, with sporanges (producing ciliated zoospores) either external, attached to the jointed ramuli, or formed out of some of the interstitial cells. British genera:

* *Frond rigid; each articulation composed of numerous cells* (Sphacelarieæ).

1. *Cladostephus.* *Ramuli* whorled.
2. *Sphacelaria.* *Ramuli* distichous, pinnated.

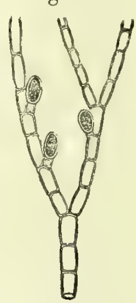
** *Frond flaccid; each articulation composed of a single cell.*

3. *Ectocarpus.* *Frond* branching; *ramuli* scattered.
4. *Myriotrichia.* *Frond* unbranched; *ramuli* whorled, tipped with pellucid fibres.

Bibl. See the genera.

ECTOCAR'PUS, Lyngb.—A genus of Ectocarpaceæ (Fucoid Algæ), consisting of olive or brown sea-weeds, with fronds composed of flaccid capillary filaments, growing between tide-marks, or upon other Algæ. Filaments of very simple structure, the main axes or branches being composed of single rows of cells (fig. 183), as in *Cladophora.* The reproductive bodies at present known, ciliated zoospores, are formed in the cells of the branches, sometimes in the terminal cells, producing the siliquose or elliptical (fig. 183) sporanges, and sometimes in interstitial cells, beyond which the branch is prolonged into a fine filament. In *E. siliculosus* the extremities of the branches are converted into sporanges: the cell-contents first divide into a number of layers, while the part of the filament containing these swells up and acquires the pod-like form; the layers of contents are then resolved into lines of zoo-

Fig. 183.



Ectocarpus verminosus.

Portion of a filament bearing lateral elliptical sporanges.

Magn. 50 diams.

spores piled regularly one above another. The summit of the pod finally bursts, and the zoospores escape. The empty sporange exhibits fine transverse striæ, as if delicate septa existed between the layers of zoospores. In *E. litoralis*, Harv., the fertile cells are not terminal, but interstitial, and form beaded rows surmounted by a hair-like prolongation of the branch; the zoospores escape by a lateral pore. The germination of these zoospores has been observed by Thuret. Sixteen British species (Harvey), some of which are common, particularly the two above mentioned.

BIBL. Harvey, *Mar. Alg.* 58, pl. 9 *c*; *Phyc. Brit.* pls. 162, 197, &c.; *Eng. Bot.* pls. 2290, 2319, &c.; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. p. 234, pl. 24. figs. 1–7; Agardh, *Ann. Sc. Nat.* 2 sér. vi. p. 197; Crouan, *ibid.*, xii. p. 248, pl. 5.

ECTOPLEU'RA, Agassiz.—A genus of Hydroid Polypi, fam. Tubulariidæ.

E. Dumortierii. Isle of Man, Ostend.

BIBL. Hincks, *Brit. Zooph.* 124.

EEL (*Anguilla*).—It is popularly believed that the eel has no scales. They are, however, present, but immersed in the skin; and their structure is curious (SCALES of FISH). The dried skin of the Eel, mounted in Canada balsam, exhibits well the scales, covered by the epidermis, and the beautiful layer of stellate pigment-cells.

BIBL. Yarrell, *Brit. Fishes*, ii.

EELS, in paste (ANGUILLULA GLUTINIS).

EELS, in vinegar (ANGUILLULA ACETI).

EGGS.—The minute ova of certain animals have always been favourite microscopic objects on account of their curious forms, the beautiful structure of their outer chitinous envelope, their varied colours, and the singular lids with which some of them are furnished. The most interesting are those of insects; among them we may mention the brown eggs of the puss-moth, *Cerura vinula* (Pl. 31. fig. 19); of the large and small cabbage-butterflies, *Pontia brassicæ* and *rapæ* (Pl. 31. fig. 21); of the small tortoiseshell butterfly, *Vanessa urticæ*; the angle-shades moth, *Noctua* or *Phlogophora meticulosa*; the common meadow brown butterfly, *Hipparchia Janira*; the brimstone-moth, *Rumia cratægata*; the water-scorpion, *Nepa ranatra*; the common cow-dung-fly, *Scatophaga stercoraria*, which are very common on cow-dung; the bug, *Cimex lectularius* (Pl. 31. fig. 20), *Hydrometra stagnorum*, &c.

Their surfaces exhibit markings of the most varied forms—spines, tubercles, pits or processes, sometimes of considerable length (Pl. 16. figs. 22, 23), often arranged with great symmetry, and frequently closely resembling the cellular structure of plants in appearance. Sometimes very delicate angular spaces are mapped out upon them, the intervals being most minutely dotted, as in the eggs of the common blow-fly, *Musca vomitoria* (Pl. 27. fig. 35).

It is a general fact, exemplified in both the animal and vegetable kingdom, that unicellular, or the corresponding stages or phases of the higher organisms, exhibit some kind of markings upon their external membrane or wall, as is seen in the cells of the Desmidiaceæ, the Diatomaceæ, the eggs of animals, the spores and pollen-grains, and the seeds of plants.

At certain seasons of the year, the eggs of some aquatic animals are provided with a very thick horny coat, as in the Entomostraca, *Hydra*, &c. These have been called winter-ova, from the notion that here was a defence against a low temperature; they correspond to the resting-spores or resting-stages of the Infusoria and Algæ, some of which were formerly included in the animal kingdom. The formation of this coat can scarcely have any relation to temperature, either from its structure or from its requirement in an organism which has no heat to retain. Its presence would be perfectly intelligible, however, as a means of protection from evaporation when the pools become dry; and for this purpose its structure is well adapted. It might also afford a protection against the attacks of predatory animals, many of which could easily devour an ovarian ovum, while they could not break through the horny cases of the winter ova; and these winter ova are only formed when the ova are not to be hatched soon after extrusion from the parent. The ova of those animals which are never hatched immediately after leaving the parent, have always a coat corresponding to that of the winter ova.

The structure and development of eggs are considered under OVUM; see also SHELL.

BIBL. See OVUM.

EHRENBERGI'NA, Reuss.—A Cassiduline Foraminifer with the later portion of the shell uncoiled.

BIBL. Carpenter, *Introd. Foram.* 198.

ELACHIS'TEA, Fries.—A genus of Myrionemaceæ (Fucoid Algæ). Minute epiphytic sea-weeds, consisting of a dense

tuft of simple, articulated, olivaceous filaments, from a common tubercular base composed of a closely combined mass of dichotomously branched filaments, growing upon larger Fucoids, such as *Fucus*, *Himanthalia*, *Cystoseira*, &c. The fructification is borne in two forms—unilocular (*spores*, Harvey) and multilocular *sporanges* (*paranemata*, Harvey). The unilocular are formed of metamorphosed terminal cells at the ends of the dichotomous filaments; they are long ovoid sacs, the contents of which are ultimately converted into a vast number of zoospores. The multilocular sporanges arise in exactly the same place and way, but take the form of long, slender, articulated filaments, in the joints of which similar but smaller zoospores are developed. Both forms of fructification nestle on the surface of the tubercle of the frond, at the base of the long simple filaments. The zoospores of both kinds of fruit germinate; and these occur together in some cases (*E. attenuata*), in others at different seasons of the year. Harvey describes seven British species; the tufts of some are half an inch long, of others less than a line.

BIBL. Harvey, *Mar. Alg.* p. 49, pl. 10 F; *Phyc. Brit.* pls. 240, 260, 261, &c.; Dillw. *Conferv.* pl. 66 &c.; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. p. 236, pl. 25. figs. 1–4.

ELÆAGNA'CEÆ.—A family of Dicotyledons, the leaves of which are usually covered with a kind of scurf formed of very elegant microscopic scales. See HAIRS and HIPPOPHAË.

ELAPHOMY'CES, Nees.—A genus of Tuberacei (Ascomycetous Fungi) consisting of subterraneous truffle-like plants, with a warty or hairy rind, not bursting spontaneously, but divided into little chambers internally by intersecting plates of sporiferous tissue. The spores are formed in sacs (*asci*) (fig. 185), from four to eight in each, arising from branched anastomosing filaments (*capillitium*). Three species are found in this country:—*E. anthracinus*, Vitt., in clayey ground; *E. granulatus*, growing in heathy ground; and *E. muricatus*, Fr. (*E. variegatus*, Vitt., Tulasne), attached to the rootlets of beeches. L. and C. Tulasne have carefully analyzed this genus.

BIBL. Berk. *Brit. Flora*, ii. pt. 2. p. 306; *Ann. N. H.* vi. p. 430, pl. 11. fig. 10; L. and C. Tulasne, *Ann. Sc. Nat.* 2 sér. xvi. p. 5, pls. 1–4; *Hypog. Fungi*, 1850; Vittadini, *Monog. Tuber. App.* p. 66, &c., pls. 3 & 4; Berk. & Br. *Ann. N. Hist.* xviii. 81.

Fig. 184.

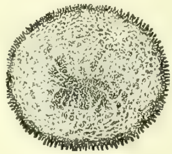


Fig. 185.

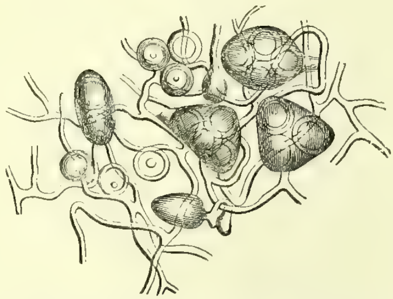
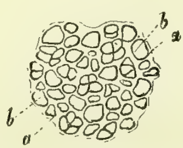


Fig. 184. Elaphomyces hirtus. Section, nat. size.
Fig. 185. E. variegatus. Filaments of capillitium, with asci containing spores, and also loose spores which have escaped. Magnified 300 diameters.

ELASTIC LIGAMENTS.—These are yellowish strong bands, consisting of elastic or yellow fibrous tissue, with a small quantity of areolar tissue. They are met with connecting the arches of the vertebræ (ligamenta subflava), in the stylo-hyoid and internal lateral ligaments of the jaw, and the ligamentum nuchæ, or 'paxy-waxy,' of animals. They contain but few vessels, and no nerves. The elastic fibres (fig. 187) are from 1-7500 to 1-3500″ in breadth, slightly flattened (fig. 186), mixed with still finer and some coarser elastic fibres, forming a dense network, taking a general direction parallel to the long axis of the spine. Be-

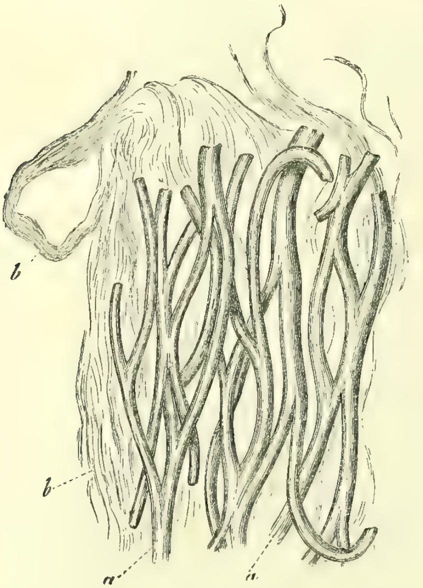
Fig. 186.



Transverse section of the ligamentum nuchæ of an ox, after treatment with solution of caustic soda: *a*, areolar tissue, appearing transparent; *b*, section of elastic fibres. Magnified 350 diameters.

tween these fibres are loose undulating bundles of areolar tissue, running parallel to the elastic fibres.

Fig. 187.



Elastic fibres: *a*, from a human ligamentum subflavum, with intervening areolar tissue, *b*. Magnified 450 diameters.

Bibl. Kölliker, *Mik. Anat.* ii. 306, and *Gewebel. d. Mensch.*

ELASTIC TISSUE of animals, or yellow fibrous tissue, occurs in the ligamenta subflava of the vertebræ, in the thyro-hyoid and cricoid membranes, the vocal chords, the trachea, forming the longitudinal elastic bands of that tube and its branches, in the internal lateral ligament of the jaw, the stylo-hyoid ligament, the transversalis fascia of the abdomen, the blood-vessels, and almost everywhere mixed with the fibres of areolar tissue.

It differs from white fibrous tissue in its elasticity and its yellow colour. But some physiologists regard it as a variety of this.

Its elementary form is that of round or flattened fibres, varying in size from an almost immeasurable tenuity to that of 1-2200″ or even more; the finer ones have been termed nuclear fibres by the Germans; they are either isolated, arranged in bundles, or branching and anastomosing (fig. 189), sometimes undulating or spiral, at others nearly straight. When broken, they curl up, the ends appearing abrupt or truncated. They are highly refractive, their edges appearing dark, well-defined, and mostly smooth, but sometimes toothed or serrated. Sometimes they exhibit transverse cracks upon the surface.

Fig. 188.

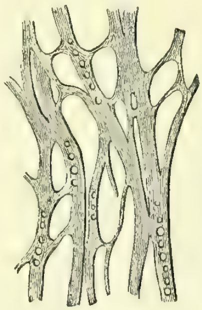


Fig. 189.

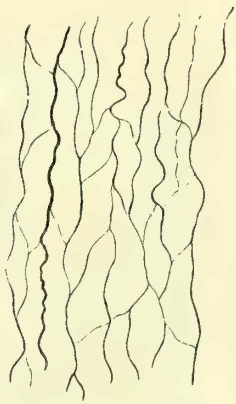


Fig. 188. Network of elastic tissue, from the middle coat of the pulmonary artery of the horse. Magnified 350 diameters.

Fig. 189. Network of fine elastic fibres from the peritoneum of a child. Magnified 350 diameters.

They are easily distinguishable from fibres of areolar tissue by the use of acetic acid, which has little or no effect upon them; and this is also the case with solution of potash. Sometimes by their anastomoses they form fibrous networks (fig. 189), or plates perforated irregularly by holes — fenestrated membranes (fig. 188). The fibres are also themselves sometimes transversely perforated by irregular rounded apertures.

The chemical composition of elastic tissue has not been accurately determined; it appears rather referable to the proteine than the gelatine group of compounds. It is coloured red by Millon's test, but not by that of Pettenkofer, and does not yield gelatine by boiling.

Elastic tissue is probably developed from cells. In all parts of embryos where elastic tissue occurs, peculiar fusiform or stellate cells (fig. 190 *a*) with acute ends or processes are met with, by the fusion of which (fig. 190 *b* & 191), long fibres or networks are formed, in which the spots corresponding to the cells at first form dilatations with elongated nuclei. The fibres frequently

remain in this condition, forming a modification of the so-called nuclear fibres; or all traces of the original composition vanish, uniform fibres or networks alone remaining. There is, however, great difference of opinion among physiologists as to the development of elastic tissue, some regarding it as arising from fibrillation of the intercellular substance.

Fig. 190.

Fig. 191.

Fig. 190. Formative cells of elastic tissue, from the tendo Achillis: *a*, of a four months' embryo; *b*, of a seven months' fœtus; some of the cells are free, with one or two processes, others fused in twos and threes. Magnified 350 diameters.

Fig. 191. Stellate formative cells of nuclear fibres, from the tendo Achillis of a newly born infant. Magnified 350 diameters.

Elastic tissue occurs in the same situations in all classes of the Vertebrata as in man—also in some special localities, as in the ligaments of the claws of the cat, the folds of the wing-membrane, and the pulmonary sacs of birds. In the Invertebrata, this tissue appears to occur but rarely; and it is uncertain whether the elastic ligaments existing in them, *e. g.* those of the mollusca, agree anatomically and chemically with the elastic tissue of the higher animals or not.

Bibl. Kölliker, *Gewebel. d. Mensch.*; Reichert, *Müll. Archiv*, 1856, Hft. vi. 55; Leydig, *Histologie*, 27; Frey, *Histol.* 1870 (very complete literature), p. 268; Beale, *Simple Tissues.*

ELATERS.—This name is applied to two forms of structure occurring in the higher Cryptogamous Plants. The elliptical spores of the Equisetaceæ are furnished with what are called elaters, viz. four elastic filaments, attached about the middle of one side, which are coiled once or twice round the spore before it is discharged from the capsule, in the position where they were originally developed; but when the spore is discharged, they uncoil with elasticity, causing the spore to be jerked away. They appear to be produced by the outer coat of the spore splitting in spiral fissures, and separating in ribands from the inner coat. See Equisetaceæ.

The elaters of the Liverworts or Hepaticæ are of different nature; they consist of more or less elongated delicate membranous tubes, which are closed cells, inside which one or more elastic spiral fibres are coiled up. They occur mixed with the spores in the capsules of the Jungermannieæ, sometimes attached to the valves; they here mostly present the appearance of cylindrical cellulose tubes, closed at the ends, with a flat spiral band coiled in an open spiral, adherent to the cell-membrane forming the wall (Pl. 32. fig. 38). The elaters found among the spores of *Marchantia polymorpha* (Pl. 32. figs. 36, 37) are very long, and contain a double coil, the ends of the two fibres coalescing into a loop at each extremity (Pl. 32. fig. 37 *b*); so that the entire fibre may be compared to a piece of string with its ends united, and laid out so as to represent two cords, side by side, which are then twisted spirally round one another. In Targionia the tubes are sometimes branched. The spiral fibres have been stated by some authors to originate from the gradual accumulation of granules in a spiral line upon the primary cell-wall: but this is erroneous; their development is similar to that of the spiral fibres of vessels. See Hepaticæ.

Structures apparently analogous to these elaters of the Hepaticæ occur in some of the Myxogastrous Fungi, as in Trichia (Pl. 32. fig. 39 *a*); while in other genera of this family filamentous bodies occur, either plain or obscurely marked. In *Batarrea* also, one of the Puff-balls, a kind of elater exists accompanying the spores (see Trichogastres). It has been stated by Schleiden

and Schacht that the elaters of these Fungi are solid filaments with spiral ridges upon them, or flat solid ribands twisted on their longitudinal axis. This statement is at variance with our observations, and is not borne out by the drawings given by these authors themselves. Currey, while also contesting Schleiden's view, states that the spiral line is a ridge outside a tube,—a condition of things unlike any thing else we are acquainted with in vegetables.

The elaters of *Trichia* require a very high power for their elucidation, an eighth or twelfth, with a high eyepiece, and a good light; they may then be seen to consist of tubes with spiral fibrous secondary deposits upon the *inside* of their walls (Pl. 32. fig. 40). See SPIRAL STRUCTURES.

BIBL. See EQUISETACEÆ, MARCHANTIA, TRICHIA, and SPIRAL STRUCTURES.

ELDER.—*Sambucus niger*, the common Elder tree (Caprifoliaceæ, Dicotyledons), is remarkable for the great development of its pith; sections of this furnish very accessible and convenient illustrations of vegetable parenchyma. This pith is also used by microscopists for cleaning their object-glasses; it is extracted from the branches in suitable lengths, dried and carefully preserved from dust. The face of the objective is polished with the end of one of these cylinders of pith, and a fresh surface is obtained every time it is used, by cutting off a thin slice with a clean razor. By this means all danger of scratching the lenses is avoided.

ELLIPSOIDI'NA, Seguenza.—An egg-shaped hyaline Foraminifer, of obscure relationship. The adult has three concentric chambers, one within another, touching at their bases and kept apart at the apices by an internal column. An irregular septal orifice surrounds the column as it passes through the chamber-wall. *E. ellipsoides* and its varieties only are known. From the Mid-Tertiary beds of Sicily.

BIBL. Brady, *Ann. N. H.* 1868, i. p. 333.

ELVELLA'CEI.—The principal order of Ascomycetous Fungi. See MORCHELLA, HELVELLA, GYROMITRA, and PEZIZA.

ELYTRA.—The horny anterior pair of wings of the Coleoptera; sometimes called wing-covers or wing-cases, because they cover and protect the subjacent pair of wings of these insects when not in use.

The elytra may be regarded as consisting of an elongated, depressed fold of the integument, comparable to the web between the fingers, or that of the bat's wing. Four structures are distinguishable in them:—1, an outer, firmly adherent, epidermic layer, composed of minute cells, frequently undistinguishable, or at least only to be detected in parts; this layer is continued around the margins of the elytra, so as to cover their inferior surface also, forming, 2, the inner epidermic layer, in which the cells are stated to be less distinct, more rounded, and more closely placed than those in the upper layer, hence presenting a more distinctly angular form; this layer is easily detached from the elytra, and its surface next the body of the insect is frequently furnished with a number of very minute hairs, or spiniform papillæ directed backwards (Pl. 27. fig. 2). Beneath the outer epidermic layer is 3, a layer of dark resinous pigment; whether contained in cells or not has not been determined. 4, an intermediate portion, composing the principal thickness of the elytrum, representing the two fused strata of the cutis, and consisting of a number of fibres, running in different directions, variously interlacing, anastomosing, and crossing, so as to form numerous plates or secondary layers, many of which present a fenestrated appearance; as many as sixteen of these plates have been separated.

The veins or nerves of the elytra either traverse the intermediate thick layer of the elytra, or run between its under surface and the inner epidermic layer, to which they sometimes remain adherent. See INSECTS.

The structure of the elytra can only be made out by macerating them for a very long time in solution of caustic potash, or water.

BIBL. Schmidt, *Taylor's Scient. Memoirs*, v. p. 16; Meyer, *Müller's Archiv*, 1842, p. 12; Nicolet, *Ann. Sc. Nat.* 3 sér. vii.; and the BIBL. OF INSECTS.

EMBRYO, OF PLANTS.—This is the name applied to the rudimentary plant contained in all true *seeds*. Seeds containing embryos are borne exclusively by Flowering Plants; and while the external conditions under which the seeds are produced afford the character for the first subdivision of this province of the Vegetable Kingdom (ANGIOSPERMS and GYMNOSPERMS), the structure of the embryo is taken as the most striking character in further subdividing the Angiospermous Flowering Plants into their two great natural groups, viz. Monocotyledons and Dicotyledons, in which, respectively, the embryo bears one or two *cotyledons* or seed-leaves. Cases occur both

among the Dicotyledons and the Monocotyledons where the typical structure is departed from. Thus in Orobanchaceæ (Dicotyledons) the embryo is a mere globular mass of cellular tissue, the result of an arrest of development, the cotyledons and radicle never becoming distinct; the same is the case in the Orchidaceæ among the Monocotyledons, the embryo not advancing beyond the state of a globular mass of parenchyma. The relation of such embryos to the perfect forms is well illustrated by comparing the stages of growth of embryos which acquire fully-developed cotyledons and radicle (fig. 192). In *Cuscuta*, a leafless plant, the

Fig. 192.

A young Dicotyledonous embryo in successive stages of development. All exhibit the suspensor; and 4 has the cotyledons appearing, separated by a notch. Magnified 50 diameters.

embryo has no distinct cotyledons. Other anomalies of another kind also occur. Some Monocotyledons, such as those of Grasses, have the rudiment of a second cotyledon; but this is *above* and *not opposite* the other larger one. In Dicotyledons the cotyledons are not unfrequently unequal, and sometimes soldered together. In the Coniferæ the embryos appear to have four, eight, or more cotyledons in different cases; but it is stated that there exist only two, divided or compound, cotyledons (see SEEDS).

Occasionally more than one embryo occurs in a seed (see POLYEMBRYONY); and in the Coniferæ a number of embryos are at first produced, of which one only becomes perfectly developed (see GYMNOSPERMIA).

The embryo sometimes constitutes the whole mass of the seed, merely enclosed in the coats; in other cases it is imbedded in a mass of albumen. In the former case the tissue of the cotyledons often assumes characters similar to those of the ALBUMEN, serving as a receptacle for stored nutriment for the germinating plant, in the form of fleshy secondary deposits, starch, oil, &c. The position of the embryo in the albumen, or the modes in which the embryo is folded up within the seed-coats, are of great importance in systematic botany, for the characterization of families. Particulars regarding these points, and the manner of examining them, are given under the head of SEED. The development of embryos is described under OVULE. See also ORCHIDACEÆ, OROBANCHACEÆ, CUSCUTA.

BIBL. Works on Structural Botany; Brongniart, *Ann. d. Sc. Nat.* xii. p. 14, &c.; Jussieu, *ibid.* 2 sér. xi. p. 341; St.-Hilaire, *Leçons de Bot. Ann. d. Sc. Nat.* 2 sér. v. p. 193; Duchartre, *Ann. d. Sc. Nat.* 3 sér. x. p. 207, and the BIBL. of the articles OVULE, SEED, &c., above referred to.

EMBRYO-SAC, OF PLANTS.—A cell which becomes enlarged into a sac in the substance of the upper part of the nucleus of the ovule or rudiment of the seed. In the cavity of this are developed the germinal vesicles (Pl. 38. figs. 3, 4, 5), one of which (occasionally more), after fertilization, gives origin to the EMBRYO. The most common condition of the embryo-sac is that of a large cavity excavated in the nucleus, bounded by its own cell-membrane, and containing abundant protoplasm, and subsequently germinal vesicles and endosperm-cells (see OVULE). Not unfrequently, however, it becomes developed into diverse saccate processes, either pushing their way through the substance of the nucleus in variable directions (*Scrophulariaceæ* &c.), or emerging from the micropyle, coming to meet the pollen-tube (*Viscum*), or even so much developed externally that the embryo is formed and perfected altogether outside the nucleus (*Santalum*). These and other conditions are further described under OVULE. When the germinal vesicle is fertilized, and is undergoing development to produce the embryo, the embryo-sac often becomes completely filled with endosperm-cells, at first free, but afterwards adhering together through their crowded condition. These may persist and form an *endosperm* to the seed, as in *Nuphar*, where there is an additional *episperm* formed outside the embryo-sac from the substance of the nucleus. Albuminous seeds generally have either an episperm or an endosperm alone. In exalbuminous seeds the endosperm originally existing inside the embryo-sac becomes absorbed through the pressure of the growing embryo, the embryo gradually filling up the cavity, and by further expansion obliterating the embryo-sac and nucleus. See ALBUMEN, of Seeds.

In the Coniferæ the embryo-sac, originally formed by the excessive expansion of one of the cells near the apex of the nucleus, becomes subsequently filled up by cellular

tissue, in the upper part of which become developed the bodies called *corpuscula*, each of which possesses a kind of secondary embryo-sac of its own, in which the germinal vesicles are developed (see GYMNOSPERMIA).

The term embryo-sac might also be applied to the large cell at the base of the archegonia of the FERNS, LYCOPODIACEÆ, MOSSES. (See these heads.)

BIBL. See OVULE and GYMNOSPERMIA.

EMPUSI'NA, Cohn. See SPORENDONEMA.

EMYD'IUM, Doyère (*Echiniscus*, Schultze).—A genus of Arachnida, order Colopoda, family Tardigrada.

Char. Head furnished with appendages; mouth conical, without appendages or terminal sucker; epidermis semisolid, presenting, especially on the upper surface of the body, an evident annular division.

1. *E. testudo* (Pl. 41. fig. 7). Reddish-brown; body ovoid, opaque; snout conical, presenting traces of division into three rings; head indistinctly divided into three segments, the first and third presenting short setiform filaments supported upon very short tubercles, the second with a palpiform, blunt and flattened appendage; pharyngeal tube very slender; styles straight; bulb without an internal jointed framework; eye-spots small, oval, simple, most visible at the under aspect of the body; trunk divided into four simple rings, with spines and long filaments; legs three-jointed, each with large and strong claws, the posterior pair with a kind of spur also at the back part of the lower margin of the second joint; movement excessively slow; length, from the end of the extended snout to the posterior border of the fourth ring, 1-80''. Found on the moss covering tiled roofs; common.

2. *E. spinulosum* }
3. *E. granulatum* } rare.

BIBL. Doyère, *Ann. d. Sc. Nat.* xiv. p. 279.

ENALLOSTE'GIA. — One of D'Orbigny's orders of Foraminifera, having the chambers alternate in two or three rows, not spiral; such as *Polymorphina* and *Textilaria*.

ENCALYP'TA, Schreb.—A genus of Calymperaceæ (Pottioid Mosses), containing several British species.

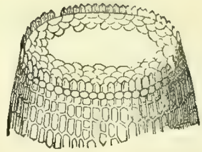
BIBL. Wilson, *Bryol. Brit.* p. 140; Berk. *Handb.* p. 246.

ENCEPH'ALOID, or ENCEPHALOID CANCER.—That form of cancer in which the morbid substance has the appearance and consistence of the medullary part of the brain; hence sometimes called medullary cancer.

See TUMOURS, CANCEROUS.

Fig. 193.

Fig. 194.



Encalypta commutata.

Fig. 193. A single plant. Magnified 5 diameters.
Fig. 194. The mouth of the capsule, showing the rudimentary peristome. Magnified 50 diameters.

Fig. 195.

Fig. 196.

Encalypta commutata.

Fig. 195. Capsule on stalk, with vaginule at base, and calyptra above. 10 diameters.
Fig. 196. Capsule enclosed in its calyptra. 20 diameters.

ENCHE'LIA, Ehr.—A family of Infusoria.

Char. No carapace; oral and anal orifices at the opposite ends of the body.

Locomotive organs consisting of cilia; not detected, however, in two species.

Ehrenberg distinguishes the genera thus:

Mouth toothless	Surface without cilia	Mouth directly truncate, no lip, oral cilia	Body single	...*Enchelys.*
			double	.. *Disoma.*
		Mouth obliquely truncate, with lip	no neck	*Trichoda.*
			a neck	*Lacrymaria.*
	Surface with cilia	Mouth obliquely truncate, with a lip		*Leucophrys.*
		Mouth directly truncate, without a lip.....		*Holophrya.*
Mouth with teeth				*Prorodon.*

Dujardin's family Enchelia bears no relation to that of Ehrenberg. He defines it as consisting of animals partly or entirely covered with cilia, scattered without order; no mouth: and subdivides it thus:—

Not ciliated all over	Cilia at one end	*Acomia.*
	Cilia in a longitudinal furrow	*Gastrochæta.*
Ciliated all over	Cilia all alike	*Enchelys.*
	Both cilia and trailing retractile filaments	*Alyscum.*
	One long straight cilium posteriorly	*Uronema.*

Bibl. Ehr. *Infus.* p. 298; Dujardin, *Infus.* p. 380.

EN'CHELYS, Hill.—A genus of Infusoria, of the family Enchelia, Ehr. (Trachelina, Cl. & Lach.).

Char. Body single, free, without vibratile cilia on the surface; mouth without teeth, ciliated, directly truncated. Aquatic.

E. pupa, E. (Pl. 23. fig. 48). Body ovate, turgid, attenuated in front, containing yellowish-green granules; length 1-144″.

E. farcimen. Smaller than the last, 1-432″; internally whitish.

E. arcuata, Cl. Aquatic.

Two other species.

Dujardin's genus *Enchelys* belongs to *Cyclidium.*

Bibl. Ehrenb. *Infus.* p. 298; Dujardin, *Infus.* p. 385; Stein, *Infus.* p. 137; Clap. & Lachm. *Infus.* p. 309.

ENCHONDRO'MA. See Tumours.

ENCYONE'MA, Kütz.—A genus of Diatomaceæ.

Char. Frustules resembling those of *Cymbella,* arranged mostly in longitudinal series, in gelatinous tubes; aquatic.

Valves very variable in form, even in the same tube, showing how little dependence is to be placed upon this feature as a character.

E. prostratum (Pl. 14. fig. 10). Filaments nearly simple; length of frustules 1-1560 to 1-600″.

E. cæspitosum. Filaments divided at the ends, tufted.

2 other European species, and 2 foreign.

Bibl. Kützing, *Bacill.* p. 82, and *Sp. Alg.* p. 61; Ralfs, *Ann. N. H.* 1845, xvi. p. 111; Berkeley, *ib.* 1841, vii. p. 449; Smith, *Brit. Diat.* ii. 68; Rabenhorst, *Fl. Alg.* i. p. 85.

ENDIC'TYA, Ehr. = Coscinodiscus in part. *E. oceanica* = *C. oc.* K.

ENDOCAR'PEÆ, Fries.—A family of Angiocarpous or closed-fruited Lichens, characterized by closed apothecia imbedded in the thallus, bursting by a distinct, regular, prominent pore or ostiole.

The genera *Endocarpon, Sagedia, Pertusaria,* and *Thelotrema* are now arranged in other families. See Lichens and the genera.

ENDOCAR'PON, Hedw.—A genus of Lichens, family Pyrenocarpei, with pale perithecia immersed in a peltate or squamiform coriaceous thallus; growing on rocks, in streams, and on the ground.

4 British species: *E. miniatum, fluviatile, rufescens,* and *hepaticum.*

Bibl. Leighton, *Angioc. Lich. Ray Soc.* 1851, p. 10, pl. 1, and *Lich. Fl.* p. 409; Tulasne, *Ann. d. Sc. Nat.* 3 sér. xvii. pp. 90, 213, pls. 10 & 12; Hook. *Br. Fl.* ii. pt. 1. p. 159; Schærer, *Enum.* p. 230, pl. 9. fig. 2.

EN'DOCHROME.—This word is in general use among Algologists in this country and in France, whence it was derived; and it is synonymous with the German *Inhalt* or *cell-contents,* being applied to the miscellaneous collection of substances and structures enclosed in the cavity of a cell. In an Alga, therefore, like *Zygnema,* it comprehends the *primordial utricle* or layer of protoplasm lining the cell-wall, together with the chlorophyll-globules or vesicles, starch-granules, nucleus, and liquid and granular protoplasm contained in the cavity of the cell. It is perhaps a useful word in roughly describing a species, but is too indefinite to be admissible in any accurate description of cellular structures; moreover, as it is not a definite collection of substances, nor always coloured, the use of the term *cell-contents* is to be preferred in all cases, as not indicating any positive characters.

ENDOCOCCUS, Nyl.—A genus of Lichens containing the parasitic species of Verrucaria.

BIBL. Leighton, *Lich. Fl.* p. 463.

ENDODRO'MEA, Berk.—A curious genus of Mucorini (Physomycetous Fungi), distinguished by a very delicate vesicle perforated by the stem, filled with delicate branched radiating threads and globose spores, each of which has a nucleus endowed with active motion. The only species, *E. vitrea,* is found on sticks in damp woods.

BIBL. *Hook. Journ.* iii. p. 79; Berk. *Outl.* p. 408.

EN'DOGEN. See MONOCOTYLEDON.

ENDO'GONE, Lk.—A genus of Mucorini (Physomycetous Fungi), consisting of one or two Hypogæous species, the flocci being collected into a globose spongy mass, and terminated by globose vesicles, solitary or in fascicles. Two species, *E. pisiformis,* Lk., and *E. lactiflua,* B. & Br., have been found in this country.

BIBL. *Ann. N. H.* xviii. p. 81; Berk. *Outl.* p. 409.

ENDOS'MOSE.—This name is applied to a phenomenon which takes place when two different liquids, having an attraction for each other, are separated merely by a porous diaphragm or an organic membrane. A diffusion takes place, by which the liquids become mixed, but one of them flows more rapidly into the other. Thus when alcohol and water are so placed, the water flows into the alcohol (*endosmose*) much more strongly than the alcohol into the water (*exosmose*). The same attraction occurs when syrup or a solution of gum is substituted for the spirit, and also alkaline salts. When acids or acid salts are placed in the same relation to water, the current is strongest towards the water. Acids and alkaline solutions exert the strongest action, neutral substances the weakest. Dilute solutions act more efficiently (proportionally) than strong ones. The importance of the effects of endosmose on microscopic objects viewed in liquids, has been mentioned in the INTROD. (xxxvi). Delicate structures are often advantageously wetted with dilute solutions of sugar, common salt, or glycerine, to prevent the changes from endosmosis which result from the use of pure water.

BIBL. Fischer, *Pogg. Ann.* xi. p. 126; Dutrochet, *Cycl. Anat. and Phys.* ii. p. 98; *Works on Physics*, as Buff, *Experim.-Physik*; Pouillet, *Elém. d. Physique*; Peschel, *Physics* &c.; Graham, *Proc. Roy. Soc.* vii. p. 83; *Watts's Dict.* (Dialysis); L'Hermite, *Ann. d. Sc. Nat.* 4 sér. iii. p. 73; Nägeli, *Physiol. Unters.* p. 20; ii. p. 316.

EN'DOSPERM. See ALBUMEN, of Plants.

EN'DOSPORE.—The name applied by some authors to the inner coat of spores. See SPORE.

ENERTHENE'MA, Bowm.—A genus of Myxogastres (Gasteromycetous Fungi), interesting from the fact that the spores have been observed *in situ*; they are produced, five or six together, in globular sacs (*asci*) attached to the free apices of the filaments of the capillitium, which arise from a disk at the top of the percurrent stem. *E. elegans* was found by Bowman near Wrexham; and it has since been found in South Carolina, and in Scotland.

In the clustered spores it resembles *Badhamia* and some species of *Reticularia* figured by Corda.

BIBL. Bowman, *Linn. Tr.* xvi. p. 151, pl. 16; Berk. and Broome, *Ann. N. H.* 2 ser. v. p. 366, pl. 11. fig. 7.

ENOP'LIDÆ, Duj.—A tribe of Nematoid Entozoa, distinguished by an oral or pharyngeal armature, consisting either of styles, hooks, or rods (bacilli). The members are microscopic, and live in fresh or sea-water, whence they sometimes find their way into the alimentary canal of higher animals. Genera:

Dorylai'mus. Filiform, narrowed at the ends; mouth tubular, retractile, armed with a single very long horny style; male with two equal, short, falciform spicules; female with the vulva in the middle of the body, the uterus divided into two opposite branches, ova large, oblong.

D. stagnalis. In the intestines of the carp and *Gasterosteus. D. marinus.* Marine.

Passalu'rus. Fusiform, elongate, narrowed behind, with a subulate tail, or suddenly narrowed; head obtuse; mouth with three oblong pieces (jaws), united by a resisting folded membrane; œsophagus clavate, succeeded by a broader stomach; skin transversely striate; male with a single spicule; female with the vulva near the stomach; uterus and ovaries simple; eggs large, oblong.

P. ambiguus. Large intestine of the rabbit and hare.

Enop'lus. Filiform, narrowed at the ends, most behind; head angular or truncate, with a few opposite setæ; mouth with three uncinate jaws; œsophagus almost cylindrical, cavity triquetrous; tail ending

in a kind of sucker; one or more red eye-like spots on the œsophagus; skin smooth; male with a supplementary orifice (anus or sucker) in front of the genital orifice, and with two equal curved spicules; vulva near the middle of the body; uterus divided into two opposite branches; eggs elliptical. Marine and freshwater.

Oncholai'mus. Filiform, more or less narrowed at the ends; head obtuse; buccal cavity large, with two or three curved or hooked jaws, placed lengthwise, at least one with a prominent tooth; œsophagus elongate, nearly cylindrical; no stomach; tail apparently terminated by a sucker; skin smooth. Male—tail suddenly narrowed, short; spicules two, equal. Female—vulva near, or slightly behind the middle; uterus two-branched; eggs elliptic, large. Marine and freshwater.

Anguil'lula (*Rhabditis*). Pharynx with two or three longitudinal bacilli.

Atrac'tis. Mouth with two or three jaws; spicula two, unequal.

Doubtful genera:

Amblyu'ra, Ehr. Filiform, mouth truncate, with cirrhi; tail subulate, slightly expanded at the end, where there is a suctorial papilla; spicule single, retractile, without a sheath. Probably species of *Oncholaimus* or *Enoplus*.

A. serpentulus = *Vibrio s.*, Müller. Found in an old vegetable infusion.

A. gordius = *Vibrio g.*, Müll. In marine infusions.

Phanogle'ne. Filiform, pointed behind; mouth truncate, bilobed, with cirrhi, and with red eye-spots behind the head; spicule single.

P. micans. Eye-spots contiguous; cirrhi two. In the intestine of the larva of a neuropterous insect.

P. barbiger. Cirrhi four; red spots separate. In stagnant water.

Enchilid'ium. Filiform, a single red eye-spot, as broad as the body, situate at some distance from the head. Marine.

See ANGUILLULIDÆ.

BIBL. Dujardin, *Helminth. &c.* 236; Nordmann, Lamarck's *Anim. sans Vert.* iii. 564; Bastian, *Linn. Trans.* xxv. 73.

ENTEROBRY'US, Leidy.—A supposed genus of Kützing's Leptomiteæ, probably the mycelium of some fungus, found in the intestines of insects.

ECCRI'NA, Leidy, is another of these forms.

BIBL. Leidy, *Proc. Nat. Hist. Soc. Philadelphia*, 1849, p. 225, *Ann. N. H.* 2 ser. v. p. 72; Robin, *Végét. Parasites*, 1853, p. 395, pl. 4. figs. 5, 6.

ENTEROMOR'PHA, Link.—A genus of Ulvaceæ (Confervoid Algæ), consisting of aquatic and marine plants, with branched, tubular, green fronds, the walls of the tubes being composed of a single flat layer of polygonal cells. Reproduction by ciliated zoospores, formed in considerable numbers from the transformed contents of the cells (Pl. 5. fig. 4). In this genus, Thuret states that two forms of zoospores occur,—one large and four-ciliated, the other, in fronds with a yellower tint, smaller and with two cilia; both kinds germinate. The zoospores escape from the cells by a pore on the outer surface (Pl. 5. fig. 4 *a*) near the centre of the cells; and the latter persist for some time in an empty condition. The marine forms, of which nine species are described by Harvey, are mostly from 1-2‴ to several lines in diameter, but many inches long. *E. Grevillei*, Thuret (*Ulva Lactuca*, Grev., Harv.), however, is thicker and saccate, finally bursting. *E. intestinalis*, which grows both in the sea and in brackish- and freshwater ditches, often attains a length of 2 feet and more, and varies in thickness from 1‴ to 2-3″.

BIBL. Harvey, *Mar. Alg.* p. 213, pl. 25 D, *Phyc. Brit.* pls. 63, 262, 282, &c.; Greville, *Alg. Brit.* pp. 179–82, *Sc. Crypt. Fl.* t. 313, *Eng. Bot.* 2137 & 2328; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 224, pl. 20. figs. 8–12; *Mém. de Cherbourg*, ii.; Rabenhorst, *Fl. Alg.* iii. 312.

ENTERO'PLEA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye-spots none; teeth absent; foot forked.

E. hydatina (Pl. 34. fig. 27). Body conical, hyaline; foot small; aquatic; length 1-120″.

Probably the male of *Hydatina*.

BIBL. Ehrenb. *Infus.* p. 411.

ENTOGO'NIA, Grev.—A genus of fossil Diatomaceæ.

Char. Frustules in side view triangular, containing a central triangular figure, having a broad border divided by transverse costæ into punctate or cellulate compartments: =species of *Triceratium*.

11 species. Barbadoes.

BIBL. Greville, *Qu. Mic. Jn.* 1863, p. 235 (figs.).

EN'TOMIS, Jones.—An extinct bivalved Entomostracan, known by its oval, transversely sulcate, and sometimes concentri-

cally wrinkled valves. The sulcus is nuchal and much stronger than in some of the Cypridiniform allies marked with this feature. Silurian, Devonian, and Carboniferous.

BIBL. Jones, *Mem. Geol. Surv. Edinb.* 1861, 137.

ENTOMONE'IS, Ehr. = *Amphiprora*, in part.

ENTOMOSTE'GIA. — One of D'Orbigny's orders of Foraminifera, having the chambers in two rows, alternate, coiled into a spiral. This alternation of chambers, however, in the coiled Foraminifera arises from very different modes of growth, and is not a group-character. It is due :—1, to bilateral asymmetry (*Cassidulina*); 2, to lateral elongation and intercalation of the chambers in *Robertina* (*Bulimina*); 3, to extreme alar division with interdigitation of the chambers on one face (*Amphistegina*); 4, to irregular growth of semi-annular chambers (*Heterostegina*); and 5, to tent-like cavities under umbilical flaps (*Asterigerina*).

ENTOMOS'TRACA.—A division of the class Crustacea.

Char. Free; aquatic or marine; body more or less distinctly jointed, mostly contained in a horny, leathery, or brittle shell or carapace, formed of one or more pieces, often bivalve; branchiæ attached either to the jaws or legs; legs jointed, and more or less ciliated; development accompanied by a regular moulting or change of shell, sometimes amounting to metamorphosis.

Many of the Entomostraca are very common in ponds, pools, and other collections of water. When examined with the naked eye, in a bottle or glass containing the water, they appear as minute specks, generally in active and often jerking motion.

The shell is often beautifully transparent, sometimes spotted with pigment, variously striated, reticular, or notched, sometimes spinous or tuberculated. It consists of chitine impregnated with a variable amount of carbonate of lime, which is sometimes so great as to render it brittle, and to cause copious effervescence on the addition of a dilute acid; and when boiled it turns red, like the shell of a lobster. It varies in structure, sometimes consisting of two valves, united at the back, resembling the bivalve shell of a mussel; at others it is simply folded at the back so as to appear bivalve, without really being so; or it consists of a number of rings or segments. It often presents a reticular appearance resembling that of a cell-structure.

The body itself, which is more or less intimately connected with the shell, is mostly divided into numerous segments. The head is furnished with one or two pairs of antennæ; the superior or anterior are usually smallest, and in some genera easily overlooked (Pl. 15. fig. 28 *a*); sometimes one or both of them are furnished in the male with a hinge-joint, allowing considerable flexure, so as to permit of its grasping the female (Pl. 15. fig. 8 *a*, of male; 9 *a*, of female); sometimes they are long, and provided with a tuft of filaments (Pl. 15. figs. 17, 18); at others they are simply long, and filiform or setaceous (fig. 38). In some Cypridinidæ and Conchœciidæ, the upper antennæ become organs of special sense (smell or hearing), being clothed with toothed club-shaped appendages, which arise directly from the antenna (*Conchœcia*), or from its bristle-shaped appendages (*Cypridina*). The inferior pair or posterior antennæ vary in size and structure like the former, being sometimes large and branched (fig. 28 *b*) and serving to row the animals through the water, at others resembling legs (figs. 5, 17, &c.). In some genera they are furnished with curious appendages, effecting the purpose of the hinge-jointed superior antennæ. In some, again (Cytheridæ), the lower antennæ (Pl. 14. fig. 37) are armed with a long curved 2- or 3-jointed urticating seta (*b*), connected at its base by a duct with a vesicular gland situated in the anterior part of the body (*a*). An external stalked vesicle is also sometimes found attached to this antenna.

The eyes are usually large, the pigment black or red, and the muscles and the nervous branches distributed to them from the cephalic ganglion very distinct.

A labrum or upper lip is often present, compressed and terminated by a hairy lobe (Pl. 15. fig. 35); sometimes also a labium. Behind these are situated two mandibles, furnished with either blunt or pointed teeth, often having a palpus or palp-like organ (figs. 11, 20, 34). Next to these, comes a pair of maxillæ, jaws, or foot-jaws (figs. 12, 36), furnished with spines, hooks, or claws, and sometimes branchiæ (fig. 21). Behind these is a second pair of foot-jaws (figs. 13, 22). The legs are variable in number and structure; they are often furnished with flattened processes, fringed with beautifully ciliated or plumose fila-

ments (figs. 30, 31, 32), thus exposing a large extent of surface to the water, by which respiration is effected; hence they represent gills, and are called branchiæ or branchial legs or feet; similar branchiæ are often appended to the foot-jaws; and they are in constant motion, even when the animal is at rest.

As the structure and arrangement of these parts afford characters for distinguishing the genera &c., the details are given under their respective names.

The abdomen is of variable length, jointed, with a variously lobed post-abdomen, often resembling a tail in appearance (figs. 3, 8); sometimes it is bilobed; sometimes furnished with a kind of spur near the end, for supporting the ova within the shell. In some genera the external ovaries containing the ova pass out between two of the abdominal joints, yet remaining attached, and giving a remarkable appearance to the animals (figs. 9, 38). The intestinal canal is usually straight or but slightly curved; sometimes, however, it is coiled (fig. 7). The Entomostraca are mostly herbivorous, although some are carnivorous. The sexes have not been distinguished in all the Entomostraca, although in some they are perfectly distinct. It appears also that in certain of them, reproduction takes place according to the law of alternation of generations—females only being produced through several generations, and the males appearing only at certain seasons.

The spermatozoa are often of most remarkable structure (see Spermatozoa). The ova are mostly rounded; sometimes they are covered with spines, and often brilliantly coloured. They are either hatched in the external ovaries mentioned above, or in a space between the body of the parent and the posterior part of the shell, or they are deposited in masses upon and glued to water-plants, and hatched independently of the parents.

At particular seasons of the year, the ova in certain species are furnished with thick capsules, and imbedded in a dark opaque substance presenting a minutely cellular appearance, and occupying the above-mentioned interspace between the body of the animal and the back of the shell (fig. 37 *a*). This is called the ephippium, and the ova ephippial or winter ova (Eggs).

When first hatched, the young (fig. 16) differ very strikingly in form and structure from the adults (figs. 8, 9).

The larval forms of the higher Crustacea often bear considerable resemblance to the perfect Entomostraca.

The minute structure of the Entomostraca is very difficult to determine; for although the body and shell are frequently comparatively transparent, the parts are exceedingly delicate and soft, so that they are easily crushed and mutilated, and their appearance distorted.

The Entomostraca are best preserved in solution of chloride of calcium or glycerine (see Preservation). Some use glycerine-jelly.

A large number of Entomostraca are found fossil.

Systematic arrangement.

Legion 1. *Lophyropoda.* Branchiæ attached to the organs of the mouth; legs few, not exceeding five pairs, serving for locomotion, articulations mostly more or less cylindrical; antennæ two pairs, one pair used as organs of motion.

Order 1. **Ostracoda.** Shell consisting of 2 valves, entirely enclosing the body; feet 1–3 pairs, adapted for progression; no external ovary.

Sect. 1. Podocopa. Inferior antennæ simple, subpediform, geniculate, clawed at the end. (Includes all the fresh-water and most of the marine Ostracoda.)

Fam. 1. Cypridæ. Superior antennæ mostly 7-jointed, with a dense brush of long setæ; eye usually single; feet 2 pairs, the last bent up between the valves; abdominal rami 2, elongate, clawed at end.

Gen.: *Cypris* (Pl. 15. figs. 5 & 19), *Candona*, *Cypridopsis*, *Paracypris*, *Aglaia*, *Notodromas*, *Pontocypris*, *Argillœcia*, *Bairdia*, *Macrocypris*, and *Chlamydotheca*.

Fam. 2. Cytheridæ. Superior antennæ 5–7-jointed, setigerous or spinous; inferior 4–5-jointed, without a brush; feet 3 pairs, ambulatory; post-abdomen rudimentary, consisting of 2 very small lobes. (Comprises most of the marine species, and almost all the numerous fossil species.)

Gen.: *Cythere*, *Limnocythere* (Pl. 15. fig. 26), *Cytheridia* (*Eucythere*), *Ilyobates*, *Loxoconcha*, *Xestoleberis*, *Cytherura*,

Cytheropteron, *Bythocythere*, *Cytherideis*, *Sclerochilus*, and *Paradoxostoma*.

Sect. 2. Myodocopa. Inferior antennæ 2-branched: one branch rudimentary, the other powerful, many-jointed, with long natatory setæ; mandibular palp very large, subpediform, geniculate, not branchial. Post-abdomen with 2 broad plates, clawed.

Fam. 3. Cypridinidæ. Feet 1 pair, vermiform, annulated, long; mandibles obsolete; second pair of jaws with a large branchial plate; eyes, 2 compound, 1 simple.
Gen.: *Cypridina*, *Asterope*, *Bradycinetus* (*Eurypylus*), *Philomedes*, *Cylindroleberis* (*Cypridella*, *Cyprella*, *Entomis?*, fossil).

Fam. 4. Entomoconchidæ.
Gen.: *Heterodesmus*, *Entomoconchus*.

Fam. 5. Conchœciidæ. Feet 2 pairs, posterior rudimentary; mandibles distinct; eyes none.
Gen.: *Conchœcia*, *Halocypris*.

Sect. 3. Cladocopa. Inferior antennæ 2-branched, both branches well developed, natatory; upper antennæ natatory, not geniculate, with a lash of long setæ; mandibles distinct, palp short; 2 pairs of thoracic appendages—anterior large, natatory, posterior membranaceous and branchial.

Fam. 6. Polycopidæ. *Char.* Those of the section.
Gen. *Polycope*.

Sect. 4. Platycopa. Lower antennæ 2-branched, flattened; branches few-jointed, with numerous setæ. Superior antennæ strong, geniculate, shortly spiniferous; mandibles small, palp large; 3 pairs of thoracic appendages, all maxilliform; first and second pairs of jaws with a large branchial plate.

Fam. 7. Cytherellidæ.
Gen. *Cytherella*.

Order 2. **Copepoda.** Shell jointed, forming a buckler, enclosing the head and thorax; legs five pairs, mostly adapted for swimming; ovary external.

Fam. 1. Cyclopidæ. Head consolidated with the thorax; foot-jaws two pairs, generally small; fifth pair of legs rudimentary; eye single; both superior (larger) antennæ in the male furnished with a swollen hinge-joint.
Cyclops. Foot-jaws large and strong, branched; ovaries double (Pl. 15. figs. 8, 9).
Canthocamptus. Foot-jaws small, simple; ovary single (Pl. 15. fig. 6).
Arpacticus. Foot-jaws stout, terminated by a claw; ovary single.
Alteutha. Foot-jaws small, simple; body flat; a strong falciform appendage to the fifth segment of the body on each side (Pl. 14. fig. 3).
Tachidius, *Dactylopus*, *Delavallia*.

Fam. 2. Diaptomidæ. Head consolidated with the first joint of thorax; foot-jaws three pairs, well developed; last pair of legs differing in structure from the others, and differing from each other in the two sexes; eye single, sometimes pedunculated in the male; right antenna only with the swollen hinge-joint in the male.
Diaptomus. Cephalothorax and abdomen each of five segments (Pl. 15. fig. 38).
Temora. Cephalothorax of five, abdomen of three segments.
Anomalocera. Cephalothorax of seven, abdomen of four segments (Pl. 14. fig. 6).
Dias.

Fam. 3. Cetochilidæ. Head consolidated with first joint of thorax; foot-jaws three pairs, strongly developed; eyes two; right antenna only with the hinge-joint in the male.
Cetochilus (Pl. 14. fig. 21).
Notodelphys. Provisionally (Pl. 14. fig. 22).

Legion 2. *Branchiopoda*. Branchiæ attached to the legs; legs from four to sixty pairs.

Order 1. **Phyllopoda.** Legs from eleven to sixty pairs in number, joints foliaceous and branchiiform, chiefly adapted for respiration and not motion; eyes two or three, sometimes pedunculated; antennæ one or two pairs, neither adapted for swimming.

Fam. 1. Branchipodida. Body not enclosed in a carapace or shell; antennæ two pairs, the inferior horn-like, and with prehensile appendages in the male; legs eleven pairs.

Artemia. Tail simply bilobed; no appendages at the base of the cephalic horns.

Branchipus. Tail formed of two plates, cephalic horns with fan-shaped appendages at the base (Pl. 15. fig. 3).

Fam. 2. Aspidophora. Body enclosed in a shell; antennæ one or two pairs; legs more than eleven pairs.

Apus. Shell flat, buckler-like; antennæ one pair, small; eyes sessile.

Nebalia. Shell folded at the back; antennæ two pairs, large; eyes stalked (Pl. 14. fig. 28).

Fam. 3. Dithyrida. Bivalve.
Limnadia, Estheria, Limnetis.

Order 2. **Cladocera.** Legs four to six pairs, chiefly branchial; eye single, and very large; antennæ two pairs, inferior large, branched and adapted for swimming.

Fam. 1. Daphniadæ. Superior antennæ small; inferior large, two-branched; legs five or six pairs, all enclosed within the carapace; eye single, large.

* (Daphnina.) Legs five pairs; inferior antennæ two-branched, one branch four-, the other three-jointed.

Daphnia. Head produced below into a beak; superior antennæ very small (Pl. 15. fig. 28).

Moina. Head rounded and obtuse; superior antennæ large (Pl. 14. fig. 26).

Macrothrix. Head beaked, beak directed forwards; superior antennæ one-jointed, hanging from the beak (Pl. 14. fig. 25).

Bosmina. Head terminating in a sharp direct beak; superior antennæ long, many-jointed, projecting from end of beak (Pl. 15. fig. 2).

Drepanothrix, Lathonura, Acantholeberis, Ilyocryptus.

** (Sidina.) Legs six pairs; inferior antennæ two-branched; a row of spines arising from the edge of larger branch; superior antennæ of moderate size.

Sida. One branch of inferior antennæ three-, the other two-jointed (Pl. 14. fig. 27).

Daphnella. Both branches two-jointed (Pl. 15. fig. 27).

Fam. 2. Polyphemidæ. Inferior antennæ two-branched, one branch four-, the other three-jointed; lower part of shell forming a large vacant space for containing the ova and young; eye very large; legs four pairs, not contained within the shell.

Polyphemus. Tail-like abdomen projecting outside the shell; aquatic (Pl. 14. fig. 29).

Evadne. Abdomen scarcely projecting from the shell; marine (Pl. 14. fig. 30).

Fam. 3. Lynceidæ. Superior antennæ very short; inferior of moderate size, branched, each branch three-jointed; legs five pairs; eye single, with a black spot in front; intestine convoluted, having one complete turn and a half.

Eurycercus. Shell subquadrangular, abdomen forming a flat, densely serrated plate (Pl. 15. fig. 39).

Chydorus. Nearly spherical; beak very long, sharp, and curved; inferior antennæ very short (Pl. 15. fig. 7).

Camptocercus. Ovoid; abdomen long, slender, and very flexible, serrated (Pl. 15. fig. 4).

Acroperus. Somewhat harp-shaped, with an anterior inferior obtuse angle; inferior antennæ rather long (Pl. 14. figs. 1, 2).

Alona. Quadrangular, striated or grooved longitudinally; inferior antennæ short (Pl. 14. figs. 4, 5).

Pleuroxus. Gibbous above and anteriorly; obliquely truncate below; first pair of legs very large (Pl. 14. fig. 32).

Peracantha. Oval, lower end with a curved posterior point, fringed inferiorly and antero-superiorly with strong hooked spines (Pl. 14. fig. 31).

Monospilus.

See Crustacea and Siphonostoma.

Bibl. Baird, *Brit. Entomostr.*; M.-Edwards, *Crustac.* iii.; Straus, *Mém. d. Mus.* 1819, v. p. 380, and 1821, vii. p. 33; Koch, *Deutschl. Crustac.*; Desmarest, *Crustac.*; Jones, *Entom. Cretac. Form.* (*Palæont. Soc.*); *Entom. Tert.*, and *Foss. Estheriæ*; Zencker, *Müller's Archiv*, 1851 (*Micr. Trans.* i. p. 273); Morris, *Brit. Fossils*, 98; Lubbock, *Linn. Trans.* xxiii. p. 176, and xxiv. p. 197; Baird,

Ann. N. Hist. 1862, ix. p. 132, and x. p. 1; Plateau, *Ann. N. H.* 1869, iii. p. 12; Schœdler, *Cladocera* (3 pl.), 1863; Claus, *Copepoda &c., Qu. Mic. Jn.* 1861, p. 285; id. *Sieb. u. Köll. Zeitsch.* 1865 (*Qu. Mic. Jn.* 1866, p. 32); Brady, *Ann. N. H.* 1864, xiii. p. 59 (*New Ostracoda*), and 1868, ii. (*Ostr. from Scandinavian Seas, Mauritius, &c*), and 1869, iii. p. 45; id. *Linn. Trans.* 1868, xxvi. p. 353 (*Monogr. Ostracoda*); Norman and Brady, *Monogr. &c.* 1867; Sars, *Oversigt af Norges Mar. Ostrac.* 1865; Lilljeborg, *De Crustaceis* &c. 1853; Zencker, *Müll. Arch.* 1850 (*Cypris*); ibid. 1851; id. *Arch. Naturg.* 1854; Dana, *Classif. Crust.* 1853, *Report on Crust. U. S. Exped.* 1855; Grube, *Esth. u. Limnad. Archiv Nat.* xxxi. 1865; Brady and Robertson, *Ann. N. H.* 1872, ix. p. 48; and the BIBL. of the genera.

ENTOPHY'SALIS, Kütz.—A genus of Palmellaceæ (Confervoid Algæ).

Char. Frond globose, cartilaginous, containing numerous more or less confluent families of minute oblong cells.

E. granulosa. On marine rocks. Dalmatia.

BIBL. Kützing, *Phyc. Gen.* 177, pl. 18.

EN'TOPHYTES.—A general term applied to parasitic plants (chiefly Fungi), growing in the interior of animal or vegetable structures. See PARASITES, VEGETABLE.

ENTOP'YLA, Ehr.—A genus of Diatomaceæ.

Char. Frustules prismatic, compressed, compound, arcuate; the two end valves transversely striated, not alike, one of them being convex outwards, the other concave, and with a large pore (?) at each end.

E. australis. Valves linear, rounded at each end, with more than forty transverse costæ, traversed by a longitudinal flexuous line; inner plates in the adult state sixteen, in the young state only three; marine, and found in guano; length 1-240″, in the young state 1-720″, and with only six costæ between the pores.

BIBL. Ehr. *Berl. Ber.* 1848, p. 6; *Ann. N. Hist.* 1848, i. 393.

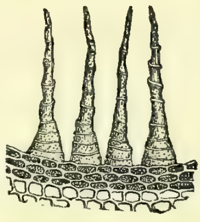
ENTOSOLE'NIA, Ehrenb.—A *Lagena* is said to be Entosolenian if it has its neck, or stolon-tube, growing inwards (introverted). This was once thought to be a generic character; but it occurs in *Polymorphina*, and is not even of specific value.

Entosolenia (*Lagena*) *globosa*, Pl. 18. fig. 23, *a, b*, is a very common form, recent and fossil.

BIBL. Carpenter, *Introd. Foram.* 157.

ENTOS'THODON, Schwägr.—A genus of Funariaceæ (Acrocarpous Mosses), inclu-

Fig. 197.



Entosthodon Templetoni.
Fragment of the peristome. Magnified 100 diams.

ding some of the *Gymnostoma* and *Weissiæ* of authors.

BIBL. Wilson, *Bryol. Brit.* p. 272; Berkeley, *Handb.* p. 175.

EN'TOTHRIX, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ).

Char. Frond tubular, composed of numerous very slender filaments, densely twisted into a cord, and enclosed in a lamellar sheath.

E. funicularis. Filaments continuous, brownish, flexuous. In long-kept water.

BIBL. Kützing, *Phyc. Gen.* 224, pl. 5. fig. 8.

ENTOZO'A.—A class of Animals; by some recent authors forming an order of the Annulata.

The Entozoa are animals mostly residing parasitically, during either the whole or a part of their lives, in the cavities or in the substance of the organs of other animals; they are very generally met with throughout the Animal Kingdom; and they derive their nourishment from the liquids of those animals of which they constitute the parasites. Their form is mostly elongate, and the body more or less distinctly jointed.

The integument consists of a delicate homogeneous epidermis, often thrown into transverse folds; sometimes also into longitudinal folds, giving the body a winged appearance. In some species it is furnished with papillæ, spines, or horny reflexed prickles, either scattered over the greater part of the surface or confined to the anterior extremity of the body, in the latter case serving as organs of adhesion. Beneath the epidermis is the cutis, intimately fused

with or almost entirely consisting of layers of transverse, longitudinal, and oblique flattened fusiform muscular fibres, resembling the organic or unstriped muscular fibres of the Vertebrata.

Beneath or in the substance of the skin, in the Cestoid Entozoa, are numerous minute oval or rounded bodies, containing carbonate and phosphate of lime; these are regarded as forming the rudiments of a cutaneous skeleton, and they possess a concentric laminated structure.

The form and structure of the head and its appendages, in the shape of hooks, suckers, &c., are described with the genera and species, as their form and arrangement are used as generic characters.

The nervous system of the Entozoa is not well known. In the cystic or larval forms, none has been detected. In the Cestoids and Acanthocephala, it appears to consist of a single cephalic ganglion, sending off branches to the proboscis. In the Trematoda, of two œsophageal ganglia, connected by a transverse cord, and sending off two lateral branches, which traverse the body longitudinally. In the Nematoidea, it is composed of a single longitudinal cord, furnished at its origin and termination with a ganglion.

Organs of special sense appear to be absent in the Entozoa, excluding that of touch, which resides in the various cephalic appendages. In some, especially in the ciliated embryonic form, there are red or black cervical spots, which have been regarded as eyes; but they do not appear to contain any refracting body comparable to a lens. Helminthologists have differed as to the presence of a digestive, circulating, and water-vessel system in the Cestoidea and Acanthocephala, certain tubes found in them being regarded as belonging to each of these systems by different authors; the longitudinal vessel-like tubes with lateral branches terminating in a caudal pore, are, however, now regarded as excretory organs. In most of the remaining Entozoa, the digestive apparatus is well developed, the mouth distinct, the posterior portion of the alimentary tube much ramified, and terminating either in a cæcal extremity or in a distinct anus. Remarks upon these systems will be found under the genera.

Propagation.—The Entozoa are propagated by spontaneous division, by gemmation or the formation of gemmæ, and by sexual organs; and they illustrate the law of alternation of generations.

The spontaneous division, which is always transverse, differs from that of the Infusoria and Polypi, in the new individuals produced not being perfect—a certain number of organs only being reproduced, as in the joints (proglottides) of the body of the Cestoidea.

The formation of gemmæ occurs in the larval or cystic forms of *Tænia*—*Cœnurus* and *Echinococcus*.

In those Entozoa which are propagated by sexes, the individuals are either hermaphrodite or unisexual. In the Cestoidea the sexual organs are usually repeated in each joint, except those near the head. And it appears that there are two kinds of ovaries —one for the production of the germ (the germinal vesicle and spot), and the other for the yolk. In addition to which, there is mostly a uterus, vagina, testis, penis (spiculum), and vesicula seminalis. The ova are round or oval, often furnished with a shell, which sometimes has a lid.

The development of the ova of the Entozoa takes place according to two methods: either the yolk-mass undergoes the ordinary process of segmentation, ultimately forming the embryo; or large transparent embryonal cells form in the yolk, the latter not becoming segmented, but undergoing subdivision and diminution in size, the growth of the embryonal cells continuing at the expense of the yolk-mass until it is entirely consumed; the entire mass then becomes covered with a delicate epithelium, which is sometimes ciliated, and forms the embryo.

In numerous instances, after this primary stage of development—the embryonal-cell condition—has been attained, the embryo does not become directly developed into a form of being resembling the parent; but the intermediate larval or nurse forms, described under GENERATIONS, ALTERNATION OF, are produced from it by a non-sexual process; and ultimately, forming the last stage of the metamorphosis, beings resembling the parent, and furnished with sexual organs, are produced. The discovery of the alternation of generations has brought to light the fact that many of the supposed species of Entozoa are only the larval or nurse forms of the true species, and that many of these forms only complete their stages of metamorphosis when placed under particular circumstances, *i. e.* in the bodies

of different animals, or in different organs of the same animal.

The following arrangement may serve as an index to the articles upon the Entozoa, contained in this work:—

Order 1. **Sterelmintha.** Alimentary canal often absent, or not distinct; when present, with a single orifice only, and branched.

Fam. 1. CESTOIDEA (tape-worms). Body strap-shaped, distinctly or indistinctly divided into transverse joints; male and female organs in each joint; alimentary canal doubtful or indistinct.
Bothriocephalus, Tænia.
(*Cystica*) Nurse or larval forms of Cestoidea:
Cysticercus, Cœnurus, Echinococcus.

Fam. 2. TREMATODA. Body mostly flattened; alimentary canal distinct, branched; male and female organs in each individual.
Amphistoma, Diplozoon (*Diporpa*), *Distoma* (*Cercaria*), *Gyrodactylus.*

Fam. 3. ACANTHOCEPHALA. Body flattened, transversely wrinkled, becoming cylindrically distended by the imbibition of water; sexual organs in separate individuals.
Echinorhynchus.

Fam. 4. GORDIACEA (hair-worms). Body filamentous, cylindrical, alimentary canal present; sexes separate.
Gordius, Mermis.

Fam. 5. GREGARINIDA. Perhaps larval states of some other organisms.
Gregarina.

Order 2. **Cœlelmintha.** Alimentary canal present, distinct, simple, with two orifices.

Fam. 1. NEMATOIDEA (roundworms). Body cylindrical, hollow; sexes separate.
Trichocephalus, Filaria, Ascaris (*Oxyurus*), *Anguillula, Trichina.*

See ACEPHALOCYSTS and ENOPLIDÆ.

BIBL. Siebold, *Vergleich. Anat.*; Rudolphi, *Entoz. Hist. Nat.* and *Entoz. Synops.*; Dujardin, *Helminth.*; Bremser, *Icones Helminth.*; Owen, *Todd's Cycl.* ii. 111; Blanchard, *Ann. d. Sc. Nat.* 3 sér. *Zool.* vii. viii. x. xi. xii; Diesing, *Helminth.*; Vogt, *Zool. Briefe*; Beneden, *Les vers cestoïdes*, 1850; id., *Vers intestin.* (27 pl.), and *Icon. d. Helm.* 1860; Pagenstecher, *Trematod. larven.* &c.; Kückenmeister, *Parasiten*, 1856; Cobbold, *Entozoa*; Eberth, *Nematoden*, 1863; Schneider, *Nematoden* (22 pl., 130 cuts), 1866; Wagener, *Cestoden* (22 pl.); Leuckart, *Menschl. parasit.* 1863.

EOS'PHORA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes three, sessile—two frontal, one cervical; foot forked. Aquatic. Among *Confervæ.*

There are three species.

E. digitata (Pl. 34. fig. 28; fig. 29, teeth). Body conical, hyaline, not auricled, toes one third of the foot in length. Length 1-96″.

BIBL. Ehr. *Infus.* p. 451.

EOZÖ'ON, Dawson.—A Foraminifer, with hyaline and vascular shell-structure, and very numerous irregular chambers, outspread for about a square foot, and heaped up nearly half as high, with diminishing size. It occurs imbedded in the Laurentian and other old limestones of Canada, Bohemia, &c. The chambers, tubuliferous layer, stolons, pseudopodial passages, and canal-system are represented by delicate casts of magnesian silicates, such as pyroxene, serpentine, and loganite; sometimes by calcite, like that of the shell itself. In the former case they can be separated by the removal of the calcareous shell, in slices of the marble, by dilute acid.

Layer after layer of Eozöon formed banks, thus constituting a large proportion of the massive limestones; and the sarcode was mostly replaced by hydrous silicates, such as have been injected into the pores of Silurian and other fossils, and just as glauconite takes the place of the soft parts of Foraminifera, Polyzoa, &c. in existing seas. The Eozöonal limestone, with its associated muds, sands, and shingle, has been folded, crushed, and variously metamorphosed, often in a high degree.

BIBL. Logan, Dawson, Carpenter, and Hunt, *Quart. Journ. Geol. Soc.* 1865, xxi. 45, and 1867, xxiii. 257; Carpenter, *Intel. Observ.* 1865, vii. 278; Gümbel, *Sitz. bayer. Akad.* 1866; King and Rowney (disputing the organic character of Eozöon), *Proc. Roy. Irish Acad.* ser. 1. x. and ser. 2. i.

EPEI'RA, Walck.—A genus of Arachnida, of the order Araneidea.

E. diadema (the common autumnal garden-spider) forms a favourable object for the examination of the various structural peculiarities of spiders,—as the integument

(Pl. 2. fig. 4); the legs, with their hairs and claws (fig. 8, *a*, *b*); the toothed hairs at the end of the feet (fig. 8) show very clearly the transition from the hairs to the claws, in fact, that the latter are mere modifications of the former; also the lung-plates (figs. 9, 9 *b*); the spinnerets, the web (fig. 11), &c.

Bibl. Walckenaer, *Hist. Nat. d. Aptères*; Brandt, *Medizin. Zool.*; Walker, *Brit. Spid.* (*Ray Soc.*).

EPEN'DYMA VENTRICULORUM is the name given to a layer which coats those portions of the ventricles of the brain which are not connected with the prolongations of the pia mater—as the floor of the fourth ventricle, the aqueduct of Sylvius, the floor and the sides of the third ventricle, the fifth ventricle, with the roof, the anterior and posterior cornua, and a considerable part of the inferior cornua of the lateral ventricles. It consists of delicate ciliated (?) pavement epithelium, situated either immediately upon the cerebral substance, or upon an intermediate layer of areolar tissue, or of a soft homogeneous or granular mass. The cells are nucleated, and vary in diameter from 1-960 to 1-490″; they sometimes contain pigment.

The ependyma is considered by many anatomists a portion of the arachnoid membrane. *Corpora amylacea* are often met with beneath it, as is sometimes also brain-sand.

Bibl. Kölliker, *Mikr. Anat.*

EPHE'BE, Fr.—A genus of Lichineæ (Gymnocarpous Lichens) (tribe Lichinei, fam. Collemacei, Leighton), usually described in an imperfect state as species of *Stigonema*, a supposed genus of Algæ. *E. pubescens* has a hairy, branched, cartilaginous frond, covering the surface of damp subalpine rocks with a blackish-green felt; the branches are subulate, and the plant is diœcious; some specimens have the branches swollen into spindle-shaped *receptacles*, in which are imbedded numerous *conceptacles*, opening by a pore, lined with clavate *thecæ*, each containing eight uniseptate *spores*; other specimens bear spherical or subovoid subapical *pycnidia*, in which are immersed *spermogonia*, dehiscing by a pore, containing numerous linear *basidia* (*sterigmata*), supporting very slender oblong *spermatia*. Two supposed species of *Stigonema*, Ag. (*atrovirens* and *mammillosum*), have been found in fruit as perfect *Ephebæ*, by Thwaites. According to Flotow, forms of this Lichen have been described under many names by Kützing and others.

See Stigonema.

Bibl. Bornet, *Ann. d. Sc. Nat.* 3 sér. xviii. p. 155, pl. 7; Berk. and Br. *Ann. Nat. Hist.* 2 ser. vii. p. 188; Nylander, *Syn.* pl. 2. figs. 1 & 17; Leighton, *Lich. Fl. G. B.* p. 12.

EPHELO'TA, Wright.—A genus of marine Infusoria, fam. Actinophryina (Acinetina, Clap. and Lachm.), resembling *Podophrya*, but the tentacles pointed instead of capitate, and forming a wreath or circlet.

2 species. On *Sertularia*, and in the mouths of shells containing hermit-crabs.

Bibl. Pritchard, *Inf.* p. 562; Wright, *Ed. New Phil. Jn.* 1858, p. 7.

EPHEM'ERA, Linn.—A genus of Neuropterous Insects, of the family Ephemeridæ.

Char. Wings four; posterior filaments three; head of larva with cornua.

The larva and pupa are favourite microscopic objects, for showing the dorsal vessel, the circulation, branchial plates, &c. See Ephemeridæ.

EPHEME'REÆ.—A family of inoperculate Acrocarpous (terminal-fruited) Mosses, usually dwarf, cæspitose, or gregarious. Stem almost simple. Leaves more or less oval or lanceolate, slightly concave, pellucid, with or without nerves. Cells of the leaves parenchymatous, lax in all parts, elongate, not papillose. Capsule mostly obliquely apiculated.

British Genus.

Ephemerum. Calyptra campanulate. Inflorescence monœcious or diœcious (antheridia on a very short special branch situated near the base of the stem).

EPHEMER'IDÆ (May-flies).—A family of Neuropterous Insects.

Characterized by the minute size of the antennæ; the unequal size of the anterior and posterior pairs of wings (the latter of which are in some absent); the membranous and almost obsolete mouth; and the elongated jointed setæ at the posterior end of the body.

Body long, slender, and soft; head small, transverse-trigonate; eyes large, nearly oval, lateral; ocelli three, forming a triangle between the eyes; antennæ three-jointed, the two basal joints thick, the third forming a long slender seta. Abdomen consisting of nine joints; the terminal the longest, and gradually narrowed and furnished at the apex in both sexes with two or three long, slender, many-jointed filaments. Legs

Fig. 198.

Ephemera Swammerdamii. Nat. size.

slender; anterior pair in the males porrected, much elongated, with the tibiæ and tarsi appearing soldered together; basal tarsal joint very minute, tarsi five-jointed, terminated in the fore legs of the male by two oval pulvilli; in the four posterior legs tarsi short, five-jointed, and terminated by a large oval pulvillus, and a single broad notched claw.

These insects must have been seen by every one, rising and falling on the wing, near the banks of rivers and pools; in the perfect state their life lasts but a few hours, whence the name. The ova are deposited in the water. The larva bears a considerable resemblance to the pupa, from which it differs in the absence of rudimentary wing-covers; they are frequently mistaken for each other.

The pupa of the common *Ephemera (vulgata)* (Pl. 28. fig. 15) has the prothorax as broad as the head, transverse-quadrate; the mesothorax gibbous; the head rather small, with two short horns in front, and two horny toothed mandibles, furnished at their upper angles with a long curved horn; labrum flat, membranous, ciliated, and with the angles rounded; maxillæ small, membranous, curved, pointed at the tip, and internally setose; maxillary palpi four-jointed, and not extending beyond the front of the head; labium large, membranous, four-lobed, and furnished with a broad tongue; labial palpi broad and three-jointed; antennæ about twice the length of the head, many-jointed and ciliated; legs short, broad, and much compressed; tarsi two-jointed, with a terminal hook; abdomen nine-jointed, the six basal segments being furnished on each side with a pair of elongated, rather narrow gills or branchial plates (*a*), with long, narrow filaments at their edges, through each of which a trachea extends to the tip, the tracheæ from each contiguous pair of filaments uniting near the base, and then running to the large tube which traverses the centre of each plate; there are in all twenty-four branchial plates. At the end of the abdomen are three elegantly feathery setæ.

The pupa of *Clœon*—another of the Ephemeridæ, in which the imago has two wings and two abdominal setæ—resembles that of *Ephemera*, but has the antennæ as long as the body.

The larvæ and pupæ of the Ephemeridæ may be most easily caught in the ring-net; and are admirably adapted for showing the dorsal vessel, with its valves, and the circulation. They are perhaps best preserved in glycerine, or solution of chloride of calcium.

Bibl. Westwood, *Introd. &c.*; Pictet, *Ins. Névropt., 2nd monogr.* 1843; Curtis, *Brit. Entom.* 708; Pritchard, *Micr. Illustr.* 61 (Pl. 2. fig. of *Clœon*, pupa).

EPHEM'ERUM, Hampe.—A genus of Ephemereæ (Acrocarpous Mosses), including part of *Phascum* of authors.

Bibl. Wilson, *Bryol. Brit.* p. 27; Berkeley, *Brit. Mosses*, p. 304.

EPHIP'PIA.—The winter-ova of the Entomostraca. See Eggs and Entomostraca.

EPIBLE'MA. See the Epidermis of Plants.

EPICOC'CUM, Lk.—A genus of Stilbacei (Hyphomycetous Fungi), parasitic upon dead leaves, &c., consisting of very minute gregarious tubercles, somewhat linearly arranged, reddish or purplish, containing numerous spherical, smooth or roughish, reticulate spores. *E. neglectum* is adnate to a short pedicel. When mature the stroma is quite covered with spores about 1-2000″ in diameter. *Uredo Equiseti*, 'Br. Flora,' is an *Epicoccum* with smooth spores.

One species of *Epicoccum*, which grows on decaying vegetable matter, produces a form of what is commonly called Blood-rain. It was developed on the calico curtains of a shower-bath during the prevalence of cholera in 1834, and excited some consternation, as it was supposed to be connected with the malady. It occurred a short time afterwards in considerable abundance on a water-melon.

Bibl. Desmaz. *Ann. d. Sc. Nat.* 2 sér. xvii. p. 95; Berk. and Broome, *Ann. Nat. Hist.* 2 ser. v. p. 466, *Crypt. Bot.* p. 312; Fries, *Summa Veg.* p. 476.

EPIDER'MIS of Animals. See Skin.

EPIDERMIS of Plants.—There are few parts of the structure of vegetables that

have given rise to more discussion than the epidermal cells and the tissue they constitute. Even the term *epidermis* has become to a certain extent equivocal, since it is used by some authors in the sense in which *cuticle* is used by others, and *vice versâ*. Our limits prevent us from entering far upon the discussion; and our object here, therefore, will be to state as briefly as possible the most remarkable facts, and the explanations which are received by the best authorities.

If we gently scrape up the surface of the leaf of a hyacinth, or other soft-leaved bulbous plant, and seize a little piece of the ragged edge with a pair of fine forceps, we may strip off large pieces of what appears to the naked eye to be a thin homogeneous pellicle. When this is placed under the microscope, it is found to be composed of a layer of cells united firmly together by their sides like stones in a pavement, but loosely connected with the subjacent tissue, which adheres here and there to the detached strip in ragged patches. The firm continuous layer of cells is what botanists call the *epidermis* of plants. Such a layer of cells clothes the entire surface of the higher plants, from the Flowering plants down to those in which the organs, such as the leaves, are reduced to mere layers of cells like the epidermis itself, as in the Mosses. In a very young and delicate state, such as we find it clothing the surface of organs still concealed in buds, or of young ovules in the ovary, it has been called *epiblema* (Schleiden). A rather more solid form, but still soft and devoid of thickening layers, such as exists on the surface of the growing parts of rootlets &c., is called *epithelium* (Schleiden); both these terms appear useless, and only calculated to confuse the student still more than the use of the words epidermis and cuticle, which already endanger misconception from the very different characters of the structures called by those names in animal organs.

Fig. 199.

Cuticle of a cabbage-leaf, removed by the action of nitric acid. P, hairs; F, orifices corresponding to stomata. Magnified 250 diameters.

When a layer of epidermis is macerated in nitric acid, a thin pellicle, destitute of cellular structure, becomes detached in sheets from the outer surface of the plate of epidermal cells; this is the *cuticle* (fig. 199) of botanical anatomists, concerning which much misconception has prevailed. As epidermis advances in age it becomes considerably solidified, especially on evergreen leaves, and on shoots of shrubs &c. which remain green for a lengthened period, such as *Aucuba* and *Viscum*. In most cases, however, the epidermis of structures belonging to the stem disappears about the same time as the leaves fall off, and is replaced by the suberous layer of the bark structure, which change is evident externally by the surface assuming a brown colour, the subjacent tissue, containing chlorophyll, being hidden. The green colour of parts clothed with epidermis depends upon the subjacent tissue showing through the transparent epidermis, the cells of which are usually colourless, and filled with watery contents.

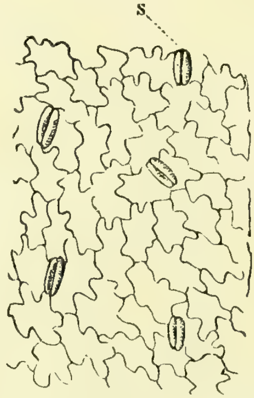
When sections are made perpendicularly to the surface of any fully developed leaf, but above all of those of leathery texture, the walls of the cells next the external surface are found much thicker than the rest, this thickening extending more or less down over the contiguous side walls. When such sections are treated with sulphuric acid and iodine, the greater part of the thickness, from without inward, of this outer wall is stained yellow, while the rest of the walls assume the blue colour ordinarily taken by cellulose with these reagents. Some authors suppose that the whole of this yellow part corresponds to the *cuticle* above mentioned: but such is not the case; if such a section is boiled or macerated for a long time in solution of caustic potash, then washed well with water and treated with tincture of iodine, the thick upper wall also assumes the blue tint, and, moreover, a laminated structure becomes evident in it, showing that it is produced by the deposition of secondary layers inside the cell. The true layer of cuticle (which is dissolved off by the continued action of potash) is really extremely thin in almost all cases. The true nature of this thickening of the outer walls is well illustrated by the epidermis of *Viscum* (Mistletoe), which remains upon

the shoots for many years; here several layers of cells subjacent to the original superficial stratum become involved in the process of solidification, and their cavities completely filled up by the secondary deposits. The true structure of the enormously thick epidermal layer of old shoots, as brought out by the action of potash, is seen in the example fig. 26 of Pl. 38. The true cuticle is sometimes of considerable thickness, as in the leaves of *Cycas* (Pl. 38. fig. 28). The thickening layers of the epidermal cells are true SECONDARY DEPOSITS. The nature of the *cuticle* is yet uncertain; some regard it as a kind of excretion hardened over the surface, others as the persistent original outer wall of the parent-cells of the epidermal cells, metamorphosed chemically where exposed directly to the action of the air (in a manner analogous to that in which the parent-cell membranes become converted into a gelatinous investment of the filaments of Confervæ, the cells of Palmellaceæ, &c.). This seems borne out to some extent by the change of condition of the consolidated part of the outer walls, coloured yellow by sulphuric acid and iodine; but it is unknown whether there is here a real chemical change, or merely an infiltration capable of being removed by the action of potash (see SECONDARY DEPOSITS).

Although the cellular plants possess no true epidermal layer, the superficial cells form a kind of cortical structure in the Lichens and larger Algæ; and in the lower Algæ the cells of the filaments &c. composing the fronds, bear some resemblance to epidermal cells in structure, insomuch that they have laminated walls (partly produced by the persistence of those of the parent cell after cell-division), with the outer layer possessing much of the physical character of the *cuticle* of the higher plants. As just mentioned, the gelatinous sheaths of the lower Algæ must be regarded as a kind of *cuticle*, and as produced by gradual disorganization of the outer layers of membrane while cell-development and the formation of new layers is going on within. For further discussion of the nature of the thickening layers of epidermis, see INTERCELLULAR SUBSTANCE.

The epidermis and its appendages offer a great variety of points of interest to the microscopist. The epidermis of those growing parts of the higher plants which are exposed to the air is not absolutely continuous and without orifices like the epidermis of roots, but is perforated with myriads of breathing-pores or STOMATA (fig. 200 S) as

Fig. 200.



Epidermis from petal of the balsam, with stomata, S. The ep rmal cells here have elegantly sinuous side-walls.

Magnified 200 diameters.

they are called. These consist of gaps left by the separation of the superficial epidermal cells at their meeting angles, the interspace between them being guarded and more or less filled up by (usually) a pair of cells, situated just beneath the outer orifice, and having a slit-like passage between them.

Hairs, *scales*, *thorns*, *stings*, and the various forms of *glands* of plants, are appendages of the epidermal structure, being produced by the peculiar development of particular cells or groups of cells of this superficial layer.

We have already alluded to the different conditions of the *epidermis* in different parts of plants. The delicate layer covering young organs in buds becomes very variously developed as these attain the complete conditions. On the leaves and shoots the epidermis becomes consolidated by secondary deposits, and this in greatest proportion on leathery or woody leaves, &c., such as those of evergreens, shrubs, and trees. Remarkable examples of this may be found in the leaves of the Proteaceæ, Cycadaceæ, the Holly, Box, &c. (woody), and in the Aloes, Cactaceæ, Oleander, *Hakea*, *Ficus*, &c. (leathery). In all cases the solid character of foliage depends almost exclusively upon the character of the epidermis by which the leaves are clothed. The epidermis of the outer scales

of winter-buds of trees is remarkably thick. The thickening layers are sometimes found on the walls of the stomatal cells and adjacent cells bounding the intercellular cavity, forming the pseudo-structure called a *cistome* (see STOMATA).

The epidermis of petals and similar delicate organs never acquires much solidity; but the outer walls often become elevated more or less above the surface, producing a minute papillosity of the epidermis, which gives the peculiar glistening appearance. When this elevation goes still further, *villi* or short hairs are produced, rendering the surface velvety (see HAIRS).

The side walls of epidermal cells are sometimes flat faces of tolerably regular geometrical figures, such as cubes, parallelopipeds, hexagonal prisms, &c.; but not unfrequently they are very sinuous, and then, when the epidermis is seen from above, it does not look like ordinary parenchyma, with square, rectangular, or hexagonal tessellæ, but the component cells are fitted together so as to present lines, which, when regular, might be described by the heraldic terms scalloped, wavy, indented, &c. (Pl. 28. fig. 15), and when less regular, resemble roughly the lines of joint in the old-fashioned puzzle-maps of children (fig. 200). Such forms of the epidermis are found on petals frequently, on the leaves of Ferns, on those of Hellebore, &c., and appear very pleasing microscopic objects, especially as, in addition to the lines, the stomata at the angles add to the elegance of the pattern.

The *cuticle* not unfrequently undergoes a change, which at present is not at all understood. This is seen on many petals, as those of the Daffodil, and on leaves, as those of the genus *Helleborus*, *Dianthus*, &c., when the epidermis is viewed from above, in the form of elevated striæ running in various ways over the surface, sometimes converging in the centre of each cell, in other cases running in tortuous lines over the surface, continuous beyond the boundaries of the individual cells. A similar condition of the cuticle occurs upon the HAIRS of many plants, especially of Cruciferæ, Ranunculaceæ, Boragineæ, &c. This condition is evidently analogous to the equally mysterious states of the outer membrane of POLLEN-GRAINS and SPORES, where points, ridges, reticulations, &c. of the same kind constantly occur.

The *stomata* are found on both surfaces of many leaves of delicate structure, but most abundantly on the lower surface; in other plants they occur exclusively on the lower face; in floating leaves they exist only on the upper face; while on submerged leaves none at all occur, and the epidermis here has no very distinct difference from that of young roots. The characters of STOMATA are spoken of more at length under that head, as also those of HAIRS, SCALES, STINGS, THORNS, GLANDS.

The epidermis of the Equisetaceæ and the Grasses is remarkable for the deposition of silica, apparently *in* the walls of the cells of the epidermis, to such an extent and so equably, that the whole of the organic matter may be removed by heat or acids, and a perfect skeleton of the structure be obtained, composed exclusively of silex, exhibiting the boundary lines of the epidermal cells and the stomata (the dentate side-walls, with the stomata arranged in linear series, are described in most microscopic books in a very curious manner, from an old paper by Sir D. Brewster). Preparations of this structure are obtained by treating little pieces of the wall of the fistular stem with strong nitric acid, to remove alkalies, and then burning them until quite white on a slip of platinum or very thin glass. These should be mounted in Canada balsam.

In the *Equiseta*, the siliceous films thus obtained are covered with minute spines, presenting somewhat the dotted appearance of the valves of the Diatomaceæ.

The seeds of many plants are clothed with an epidermis of remarkable character, the cells containing spiral fibres; this occurs in the ACANTHACEÆ, in COLLOMIA, SALVIA, &c., and is further treated under those heads and under HAIRS and SPIRAL STRUCTURES.

BIBL. Mohl, *Vegetable Cell* (transl. 1852), *Linnæa*, xvi. p. 401, *Verm. Schrift.* p. 260, *Ann. des Sc. Nat.* 2 sér. xix. p. 201, *ibid.* 3 sér. iii. p. 158, *Bot. Zeit.* v. p. 497 (1847) (transl. *Sci. Mem.* new series), *ibid.* vii. p. 593, 1849; Schleiden, *Wiss. Bot.* 3 ed. p. 335 (*Principles*, p. 70); Brongniart, *Ann. des Sc. Nat.* xviii. p. 427, 2 sér. i. p. 65; Link, *Elem. Phil. Bot.* i. p. 83; Wigand, *Intercellular-Substanz u. Cuticula*, 1850; Karsten, *Bot. Zeit.* vi. p. 729, 1848; Cohn, *Linnæa*, xxiii. p. 337, 1850; Hartig, *Entwickl. der Pfl.* 1843, *Ann. des Sc. Nat.* 3 sér. i. p. 352; Unger, *Bot. Zeit.* v. p. 289, 1847; Garreau, *Ann. des Sc. Nat.* 3 sér. xiii. 304; Mulder and Harting, *Mulder's Phys. Chem.* (Edinb. transl. p. 470, 1849); Goldmann,

Bot. Zeit. vi. p. 857, 1848; Schacht, *Die Pflanzenzelle*, p. 89. Berlin, 1852; Wiesner, *Techn. Mikr.* 1867; Henfrey, *Elem. Bot.* (Masters), 1870.

EPIPYX'IS, Ehr.—A genus of Infusoria, of the family Dinobryina.

Char. Fixed by a pedicle; eye-spot absent.

No cilia, nor appendages.

E. utriculus (Pl. 23. fig. 50). Carapace urceolate; body filled with yellowish granules; aquatic; length 1-650″.

Probably the young state of *Dinobryon sertularia*, like which it contains a disk-shaped nucleus.

BIBL. Ehrenb. *Infus.* p. 123; Stein, *Infus.*

EPISTY'LIS, Ehr.—A genus of Infusoria, of the family Vorticellina.

Char. Pedicle rigid (not contractile), simple or branched; all the bodies of the animals of the same form; aquatic.

Claparède and Lachmann refer the species of *Opercularia* to this genus.

Stein has pointed out the occurrence of the encysting-process in the species of this genus. The same author also indicates the presence of a lid-like discoidal process, protrusible from the orifice, and, like the latter, furnished with vibratile cilia; but this does not occur in all the species admitted by Ehrenberg. The species are numerous, and mostly attached to aquatic animals or algæ. Clap. & Lachm. admit 19 species.

E. anastatica (Pl. 23, fig. 51 *a*, *c*). Body small, conical, not plicate, anterior margin large and projecting; pedicle dichotomous, smooth, or covered with minute foreign bodies; entire length 1-144 to 1-14″; of single body, 1-288″.

E. grandis. Body large, broadly campanulate; pedicle decumbent, slender, smooth, laxly branched, not jointed, forming large tufts; length of body 1-140 to 1-120″.

E. vegetans (ANTHOPHYSA *Mülleri*, Duj.).

BIBL. Ehrenb. *Infus.* p. 279; Stein, *Infus.*; Claparède and Lachmann, *Infus.* p. 107; Tatem, *Mic. Trans.* 1868, p. 31.

EPIT'EA, Fr. See UREDINEI, PHRAGMIDIUM, and MELAMPSORA.

EPITHE'LIUM. — The membranous layer lining the various internal cavities, and covering the internal free surfaces of animal bodies, as the mucous canals and cavities, and their involutions forming the glands and ducts, the serous cavities, the vessels, &c.

It consists of one or more layers of nucleated cells, the form and arrangement of which are very variable. They are either round, polygonal, spindle-shaped, cylindrical, or conical. And in the deepest layers, the cells sometimes present a remarkable radiately striated appearance, having dentate margins, interlocking with those of the adjacent cells.

Three kinds of epithelium are usually distinguished; but intermediate forms are also met with.

1. Pavement- or tessellated epithelium. This consists of roundish, oval, or polygonal flattened cells, about 1-2000 to 1-500″ in diameter, and containing nuclei with nucleoli. It occurs upon the surface of the serous and synovial membranes; the membrane of the aqueous humour, the choroid, the capsule of the lens, the retina, and the conjunctiva of the bulb of the eye; the cavity of the tympanum; the lower half of the pharynx, the œsophagus, the endocardium; some veins; many glands and ducts, as the racemose, the sudoriparous and ceruminous glands; the hepatic ducts; the vagina and female urethra; the bladder, uterus, pelvis, and tubules of the kidneys; and the lungs. In the arteries and many veins the cells are spindle-shaped.

2. Cylindical epithelium. In this form the cells are either cylindrical, conical, or pyramidal, about 1-1000″ in length, and so situated that the axis of the epithelial scales or cells is at right angles to the surface upon which they are placed. Sometimes the subjacent cells are of a rounded form.

Cylinder-epithelium is met with in Lieberkühn's follicles and the ducts of the gastric as well as those of all other glands opening into the intestine; in the lachrymal and the mammary glands; the male urethra; the vas deferens; the vesiculæ seminales, the prostatic ducts, with Cowper's and the uterine glands.

3. Ciliated epithelium. In this the form and arrangement of the cells is much the same as in the last; but their free ends are furnished with numerous vibratile cilia (Pl. 40. fig. 12).

Ciliated epithelium occurs in the larynx, trachea, and bronchi; the nares and pharynx above the level of the base of the nasal bones, and the cavities opening into them; the inner surface of the membrana tympani, the Eustachian tube; the uterus, the Fallopian tubes; the lachrymal sac and nasal duct; the palpebral conjunctiva; and the ependyma.

The epithelium covering the outer surface of the body forms the *epidermis* or *cuticle*.

Further particulars are given under the heads of the organs or tissues in connexion with which the epithelia are found.

BIBL. Kölliker, *Mikr. Anat.* and *Handb. d. Gewebel.*; Valentin, *Wagner's Handb. d. Phys.*, art. *Flimmerbewegung* and *Epithel.*; Henle, *Allgemein. Anat.*; Todd and Bowman, *Phys.*; Frey, *Histologie*, 1870, p. 143.

EPITHELIUM OF PLANTS. See EPIDERMIS of Plants.

EPITHE'MIA, Brébisson.—A genus of Diatomaceæ.

Char. Frustules single, attached by a part of the surface to other bodies; valves with transverse or slightly radiant striæ, some of them not resolvable into dots.

Frustules prismatic, quadrangular, mostly curved, sometimes slightly undulating in the side view; one face of front view (that by which they are attached) flat or concave, the other convex and broader than the former, so that the transverse section forms a trapezoid. Between, or corresponding with the transverse striæ, which are not resolvable into dots, are often transverse rows of dots or depressions.

The species are numerous. Aquatic and marine. Rabenhorst dsscribes 21 European. Conjugation has been observed in three of them.

E. turgida (Pl. 12. fig. 32: *a*, side view; *b*, front view). Front view oblong, slightly dilated towards the middle; side view somewhat convex, gradually attenuated towards the very obtuse ends (Pl. 42. fig. 20). Aquatic; length 1-240''. In conjugation, Pl. 6. fig. 6 *a*, *b*, *c*, *d*, *e*.

E. gibba. Straight; inflated in the middle on each side in front view; valves gibbous in the middle on one side; aquatic and fossil; length 1-140''.

BIBL. Kützing, *Bacillar.* p. 33, and *Sp. Alg.* p. 1; Smith, *Brit. Diatom.* i. p. 13; Rabenhorst, *Sp. Alg.* i. p. 62.

EPOCH'NIUM, Lk.—A genus of Torulacei (Hyphomycetous Fungi), forming a stratum over larger fungi or dead twigs, consisting of a mycelium of irregularly branched and anastomosing filaments, which bear, on short lateral branchlets, oblong or globular septate spores, which soon fall off and lie among the mycelium-threads.

E. fungorum is very common, forming a dark-green stratum over *Thelephoræ*; *E. macrosporoideum* was found by Mr. Berkeley on a dead twig, apparently of red currant.

Sphæria Epochnii, B. & Br., has been found on *Epochnium fungorum*; and it is very probable that it is the perfect state of a conidiiferous mycelium.

BIBL. Berk. in *Brit. Flora*, vol. ii. pt. ii. p. 352, *Ann. Nat. Hist.* i. p. 263, pl. 8. fig. 14.

EQUISETA'CEÆ and EQUISE'TUM. —This is a very distinctly characterized family of Flowerless Plants, consisting of a single genus, the *Equiseta*, or Horse-tails, which are immediately recognized, when one species is known, by their peculiar aspect and habit of growth. The stems and branches are alike tubular, and present in almost all cases a rather coarsely (perpendicularly) streaked surface. The stems appearing above ground are shoots from a creeping underground stem (fig. 201), which differs from the erect stems in being of a deep brown colour and solid, in giving off root-fibrils, and sometimes in being covered with hairs. The erect stems are either *barren* or *fertile*; in the *barren stems* the joints become gradually thinner upwards from a certain point, at last tapering off to an obtuse apex; the *fertile stems* bear a kind of club-shaped head, resembling in some degree the male cones of Coniferous trees, or more particularly those of some Cycads (fig. 201). These club-shaped bodies are the fruits or heads of sporanges.

Fig. 201.

Equisetum arvense. One half of nat. size.

The anatomical structure of the rhizome and shafts presents some interesting points. In the solid rhizome the centre is occupied by cellular tissue of tolerably strong texture; outside this, as seen in a cross section, stands a circle of air-canals, each surrounded by a ring of vascular bundles; next comes a complete circle of vascular bundles composed almost wholly of annular ducts; between this vascular ring and the outside lies parenchyma like that in the centre, traversed by another concentric circle of air-canals; and immediately beneath the epidermal cells there exists a layer of compact blackish-brown parenchymatous cells. When the rhizome is coated with hairs,

these are formed by development of the epidermal cells into slender tubular processes. Tracing the solid rhizome up towards the points where the erect stems arise, the central cellular substance is gradually lost, and the outer portions are modified in their arrangement. The distribution of the air-canals and the vascular bundles varies; in some cases, the peculiarities are even regular enough to afford specific characters. The surface is clothed by an epidermis composed of elongated cells often elevated into papillæ and especially remarkable for the quantity of silica deposited in their walls. This epidermis is studded with variously formed stomata, ordinarily arranged in double lines; and the forms of the epidermal cells and stomata are perfectly preserved in the siliceous ash which remains after burning off the organic substance from a portion of this EPIDERMIS, offering a curious microscopic object. Between the epidermis and the central cavity, in a cross section lie, first, a layer of thick-walled elongated cells, within which, in the angular-stemmed species, come a circle of masses, usually crescentic, of cellular tissue containing chlorophyll. Next come usually two concentric rings of air-canals, those of the inner circle being individually surrounded by annular ducts; and, moreover, in some species a circle of 6–10 vascular bundles separates the inner from the outer circle of air-canals; the structure of the bundles is variable, exhibiting annular, spiral, and reticulated ducts. The inner circle of air-canals lies in the parenchyma which bounds the central cavity. At each joint this cavity is cut off by a diaphragm composed of three layers, in the intermediate of which, of brownish cellular tissue, lies an anastomosing ring, where ull the vascular bundles coalesce and give off branches to the sheath (and branches when present).

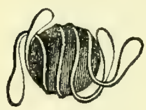
The club-shaped fruit-spikes consist of a central axis forming the last joint of the stem, on which are attached numerous mushroom-shaped *sporanges*, the stalk of each adhering to the central axis, so that we only see the upper side of the cap externally (figs. 202, 203). This has an angular border; and the adjacent sporanges being very close, the outer ends of these bodies cause a tessellated appearance of the whole in the earlier stages of development. As the sporanges ripen, they separate more from each other; and when one is removed (fig. 204), it is seen to possess a number of little pouch-like cases under the overhanging outer portion and round the stalk; these pouches burst by a perpendicular slit inwards, and discharge the spores.

Fig. 202.

Fig. 203.

Fig. 204.

Fig. 205.



Equisetum arvense.

Fig. 202. Fruit-spike. Magnified 3 diams.
Fig. 203. A spike halved vertically. Magn. 3 diams.
Fig. 204. A sporange removed from the preceding. Magn. 25 diams.
Fig. 205. A spore with elaters uncoiling. Magn. 200 diams.

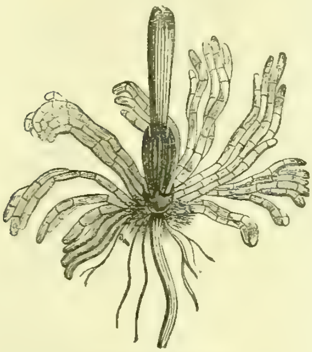
The *spores* of the *Equiseta* are very remarkable, and unlike any other known vegetable structure. They are roundish cells, with *apparently* only *one* coat; for the outer coat splits up into four thread-like processes (*elaters*), thickest and rather clubbed at their free ends. While the spore remains in the sporange, these fibres are rolled round the spore; but when the spores are discharged, the coiled fibres uncurl (fig. 205), and assist in scattering the spores, their elasticity causing them to spring out.

The *Equiseta* possess only this one kind of spore; and the germination is analogous to that of the Ferns, in which likewise only one kind of spore exists. The membrane of the spore pushes out a pouch-like process, which after a time becomes cut off by a septum; the end-cell grows on and multiplies in both directions, until a lobulated prothallium is produced; on this arise

archegonia and *antheridia* (on distinct individuals), resembling in all essential respects those produced on the corresponding structure in the FERNS.

After the fertilization of an archegonium, the germ-cell contained in it becomes developed as an embryo, and a new Equisetum-stem of the ordinary structure springs up (fig. 206), forming a creeping rhizome with

Fig. 206.



Equisetum arvense.
Young stem arising from a prothallium.
Magnified 15 diameters.

upright fistular shafts, resembling the parent plant from which the spores were derived.

The family Equisetaceæ is represented in existing vegetation by a single genus, containing only herbaceous plants. The Equisetaceæ of former ages were far more important as regards size.

BIBL. Francis's *British Ferns*, 5th ed. 1855; Thuret, *Ann. des Sc. Nat.* 3 sér. xi. p. 5; Milde, *Bot. Zeit.* viii. p. 448 (1850), and x. p. 537 (1852), *Linnæa*, xxiii. p. 545 (1850); Hofmeister, *Vergleich. Unters.* 1851, *Verh. k. Sächs. Akad. d. Wiss.* iv. p. 123; Bischoff, G. W., *Kryptogam. Gewächse*, Heft 1. p. 27, pls. 3, 4, 5 (1838), *Botan. Zeit.* xi. p. 97 (1853), transl. in *Ann. des Sc. Nat.* 3 sér. xix. p. 232; Pringsheim, *Bot. Zeit.* xi. p. 241 (1853); Sanio, *Bot. Zeit.* xiv. p. 177, xv. p. 657.

EREBONE'MA, Röm.—A supposed genus of Kützing's family Leptomiteæ. Some imperfect filamentous organism, probably belonging to a Fungus.

BIBL. Römer, *Deutschl. Alg.* p. 70; Kützing, *Sp. Alg.* p. 157.

EREMOSPHÆRA. See CHLOROSPHÆRA.

ERE'TES, Werneck.—A genus of Infusoria, of the family Cryptomonadina.

Char. Those of *Phacelomonas* with a carapace.

One species: the spores of an Alga?

BIBL. Werneck, *Ber. d. Berl. Akad.* 1844, p. 377.

ERGOT and ERGOTÆ'TIA. See CLAVICEPS.

ERIN'EUM, Pers.—A supposed genus of Fungi, really consisting of abnormal developments of the cells of the epidermis of the trees upon which they are supposed to be parasitic. They occur chiefly upon the Amentaceæ, Aceraceæ, and Rosaceæ (Apple-trees, Plum-trees, &c.).

See TAPHRINA.

BIBL. Fries, *Syst. Mycol.* iii. p. 521; Berkeley in Lindley's *Veg. Kingdom*, art. *Fungales.*

ERIODER'MA, Fée.—A genus of tropical Lichens, tribe Lecanorei, externally resembling the Peltigeræ; consisting of a green membranaceous thallus, spreading from the centre, hairy above, and with woolly anastomosing nerves beneath. Apothecia marginal, with hispid hairs on the margin underneath.

BIBL. Fée, *Crypt.* p. 145, pl. 34. fig. 2.

ERIOSO'MA. See APHIDÆ.

ERIOS'PORA, Berk. & Br.—A genus of Sphæronemei (Coniomycetous Fungi), described (*E. leucostoma*) as forming minute brown spots upon dead leaves of the bulrush. The conceptacles are globose, and collected in numbers on the stroma, bursting by a single common (white-bordered) pore to discharge the spores (stylospores), which are filiform and very slender, and arise in fours from a sporophore. (See CONIOMYCETES.)

BIBL. Berk. and Br. *Ann. Nat. Hist.* 1850, v. p. 455, pl. 11. fig. 1.

ERUPTIONS, CUTANEOUS.—The scales, crusts, scabs, contents of vesicles, pustules, &c. formed in various diseases of the skin, usually consist of epidermic cells alone, more or less flattened or otherwise altered, or of these with the ordinary products of inflammation. Granules of soot are frequently found, in London at least, mixed with the above elements; and these were once regarded as the microzymes of small-pox. Fungi exist in the crusts of some skin-diseases, as FAVUS &c. The itch-insect (SARCOPTES) must not be forgotten, nor DEMODEX. See PARASITES.

ERVIL'IA, Duj. (*Aegyria*, Cl. & Lachm.).

—A genus of Infusoria, of the family Ervilina.

Char. See the family. Marine.

E. legumen = *Euplotes monostylus*, E. (Pl. 23. fig. 52; *b*, side view). Body with two ventral contractile vesicles; length $\frac{1}{650}$–$\frac{1}{420}$''.

3 other species.

Bibl. Duj. *Infus.* p. 455; Clap. & Lachm. *Inf.* p. 288.

ERVILI'NA, Duj. (Dysterina, Cl. & Lachm.).—A family of Infusoria.

Char. Body oval, more or less depressed, entirely or partly ciliated, with a tail-like foot, usually also with a persistent membranous carapace.

Genera:

Carapace present,	
Composed of two distinct valves	*Iduna.*
Composed of two united valves.	
Valves united behind and below only	*Dysteria.*
Valves united all down the back	*Ervilia.*
Carapace absent	*Huxleyia.*

Dujardin questions whether *Urocentrum*, E., does not belong to this family.

(Dyste'ria, Huxley. A genus of Infusoria, of the family Ervilina.

Char. Distinguished from the other Ervilina by the two valves of the carapace being soldered at the posterior part behind the foot only.

5 species. Marine.

Bibl. Huxley, *Qu. Mic. Jn.* 1857, p. 78; Clap. & Lachm. *Infus.* p. 284.)

Bibl. Duj. *Infus.* p. 454; Clap. & Lachm. *Infus. &c.* p. 278.

ERY'SIPHE, Hedw. fil.—A genus of Perisporacei (Ascomycetous Fungi), consisting of little mildews overgrowing the leaves of living plants. The mycelium is formed of slender ramified filaments, which spread and form an entangled web over the epidermis of the infected plant, but do not appear to penetrate into the substance; processes, like suckers, have been discovered in the vine-mildew by Mohl, by which the threads obtain nourishment from the juices of the leaf. From the creeping mycelium arise numerous upright short-jointed filaments, the last one or more of the cells or joints of which swells so as to render the erect filament clavate or moniliform. These expanded cells become detached with the greatest readiness, and, when they fall upon the supporting leaf, germinate and produce new mycelium threads. In this state the *Erysiphæ* cannot be distinguished from the genus *Oidium*; and as this state is succeeded in most cases by the true conceptacle of the genus *Erysiphe*, the *Oidia* (such as *O. Tuckeri*, the Vine-fungus), which grow under the same circumstances, but do not produce conceptacles, are regarded by most authors as imperfect *Erysiphæ*. (See Oidium.) When the mycelium of an *Erysiphe* is developed late in the year, it seldom produces any thing but the ovate cells (*conidia*); but if developed early in the summer, the mycelium grows at certain points into denser white patches (*receptacles*, Lév.), from which arise the *conceptacles*. These are small globular sacs, composed of a double layer of cells; from the base of the outside of the sac arise a number of radiating filaments, simple or branched (*appendicles*, Lév.), while in its interior are developed one or many sacs (*asci*, *sporanges*, Lév.), in each of which are produced eight sporidia. In addition to the above, a third form of fruit occurs, in which the *conidium* becomes transformed into a sac (*pycnidium*) filled with minute spores. Tulasne has figured a second form, apparently of conidia, in *Phyllactinia guttata*.

Léveillé, in an elaborate essay on this genus, has subdivided it into five genera, which may perhaps be better taken as subgenera, and may be distinguished in the following manner:—

	Conceptacles with one ascus.	
Appendicles	dichotomously branched	1. *Podosphæria.*
„	floccose	2. *Sphærotheca.*
	Conceptacles with many asci.	
„	aciculate	3. *Phyllactinia.*
„	uncinate	4. *Uncinula.*
„	dichotomously branched	5. *Microsphæria.*
„	floccose	6. *Erysiphe.*

1. *Podosphæria.* The Hawthorn-blight and the Plum-blight belong to this division.

2. *Sphærotheca.* The Rose-mildew, *E. pannosa*, auct., belongs to this group, and is distinguished from *E. macularis*, Wallr. (*S. Castagnei*, J. Lév.), the Hop-mildew, by the appendicles of the former being white, while those of the latter are coloured. The mycelium of the rose-mildew seems to be the same thing as *Oidium leucoconium*, Desm. The similar structure of theHop-mildew has been described and figured (from Dr. Plomley's drawings) in the Trans. of the Horticultural Society. He was the first to discover the conversion of one of the oidioid cells into pycnidia.

3. *Phyllactinia.* *E. guttata*, Schlecht., common on the hazel and other trees and large shrubs, is distinguished from the other

forms of *Phyllactinia* by having a bulbous base to its appendicles, which contain 2 to 4 sporidia.

4. *Uncinula*. *E. adunca*, Schlecht, is referred here; its distinctive character is the existence of the hooked appendicles. Found on willows. *E. bicornis*, Lk., occurring upon maples &c., has eight spores.

5. *Microsphæria*. *E. penicillata*, occurring on *Viburnum Opulus* &c. Several species occur in this country, of which one of the best-known is *M. penicillata*. The characters of the appendicles, which are dichotomously branched at the tip, are the same as those of *Podosphæria*; but there are many asci, instead of one only.

6. *Erysiphe*. *E. Pisi*, Grev., is *E. Martii* of Léveillé, distinguished by its globose, many-spored asci and the simple or irregularly branched appendicles. *E. tortilis*, Lk., has coloured appendicles ten or more times the length of the conceptacle. It grows on *Cornus sanguinea*, the Dogwood tree. *E. communis*, Lév., is not very well characterized; it has coloured appendicles, which are only twice or thrice as long as the conceptacle; the asci vary from four to eight, as do also the spores contained in each. This species grows on a great variety of herbaceous plants, Ranunculaceæ, Compositæ, Leguminosæ, Cruciferæ, Polygonaceæ, &c.

Perhaps a doubt might be admitted whether the above subdivisions really represent more than six *species* of this genus.

Bibl. Léveillé, *Ann. d. Sc. Nat.* 3 sér. xv. p. 109, pls. 6–11; Berk. in *Hook. Br. Flora*, ii. pt. 2. p. 325; *Tr. Hort. Soc. London*, ix. p. 61; Greville, *Sc. Crypt. Fl.* pls. 134, 164. figs. 2, 296; Tulasne, *Compt. Rendus*, 1853; *Ann. d. Sc. Nat.* 4 sér. vi. p. 299; Tulasne, *Carpologia*, i.; Cooke, *Handbook*, p. 645.

See also Oidium.

ERYTHRÆUS, Dugès.—See Anystis.

ESPAR'TO.—The bast fibres of a grass, *Lygeum spartum* (*Stipa tenacissima*, Linn.; *Makrochloa*, Kunth), a coarse fibrous material, extensively used in the manufacture of paper. The fibres are shorter than those of most allied substances; and the epidermic wavy margined cells are so short as to render the distinction of this material tolerably easy.

It occurs extensively in the south of Europe, in North America, and in the centre and south of Spain.

Bibl. Henfrey, *Bot.* (Masters), p. 400; Wiesner, *Techn. Mikr.* p. 225 (fig.).

ESTHE'RIA, Rüppell and Straus-Dürckheim (*Cyzicus*, Audouin; *Isaura*, Joly).

A bivalved phyllopodous Entomostracon, having 24 pairs of foliaceous limbs, and ovate valves, horny, delicate, concentrically ridged, bearing from 7 to 80 lines of growth, with intermediate reticulation or other sculpturing.

26 species are known from fresh and brackish waters of warm climates; and 20 fossil species, Devonian to Tertiary.

Bibl. Baird, *Zool. Proc.* 1849, 87; 1852, 30; 1859, 232; 1860, 188 and 392; Rupert Jones, *Foss. Estheriæ* (*Pal. Soc.*) 1862; E. Grube, *Arch. f. Naturgesch.* 1853, xix. and 1865, xxxi.

EUAC'TIS, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), of the tribe Rivularieæ, consisting of little, hard, solid, elastic, mostly hemispherical bodies, from 1-2 to 2''' in diameter, growing upon stones in the sea or rivers &c.; concentrically zoned, composed of radiating, flagelliform, repeatedly sheathed filaments, the sheaths of which are open and slit above (Pl. 4. fig. 16), but connected together side by side, so as to form a tough gelatinous mass, not becoming incrusted with carbonate of lime. To this genus Kützing refers *Rivularia plicata*, *atra*, and perhaps *applanata* of Harvey. These plants are interesting on account of the fibrous decomposition of the gelatinous sheaths.

Bibl. Harvey, *Brit. Mar. Alg.* p. 222, pl. 26 A (*Rivularia*); Kützing, *Sp. Alg.* p. 339; *Tab. Phyc.* cent. ii. pls. 74–82.

EUAS'TRUM, Ehr.—A genus of Desmidiaceæ.

Char. Cells single, compressed, deeply divided into two segments, which are generally pyramidal and furnished with circular protuberances, lobed or sinuated at the margins, and emarginate at the ends.

Mr. Ralfs describes twenty-one British species, of which the following are the most common.

* *Segments deeply lobed; end lobe distinct, cuneate, partly included in a notch between the lateral lobes.*

E. verrucosum (Pl. 10. fig. 14). Rough; segments three-lobed, lobes broadly cuneate, with a shallow notch; length 1-267''.

E. oblongum (Pl. 10. fig. 15). Smooth, oblong; segments five-lobed; lobes cuneate; emarginate; length 1-156''.

E. crassum. Smooth; segments three-lobed, subquadrilateral; end lobe cuneate; length 1-190 to 1-130''.

** *Segments sinuated; end lobe exserted and united with the basal portion by a distinct neck.*

E. didelta (Pl. 10. fig. 16; 17, empty cell). Segments with inflated base, intermediate tubercles, and notched and scarcely dilated ends; side view, four shallow lateral lobes, and one at each end; length 1-185″.

*** *End lobe indistinct; frequently a process or acute angle at the corners of the terminal portion.*

E. elegans. Oblong; ends emarginate, pouting, and rounded; length 1-890 to 1-420″.

Conjugation has been observed in several species; the sporangia are spherical, with conical tubercles, or acute or obtuse spines.

Bibl. Ralfs, *Brit. Desmid.* p. 78; Rabenhorst, *Fl. Alg.* iii. p. 179.

EUCAM'PIA, Ehr.—A marine organism, allied to the Desmidiaceæ, among which it is placed by Kützing, whilst Smith refers it to the Diatomaceæ.

It forms articulated, arcuate or spiral, fasciæform, microscopic fronds, composed of hyaline wedge-shaped frustules, with yellowish granular contents. The joints shrink in drying, and are destroyed by heat. The markings consist of dots.

E. zodiacus (Pl. 41. fig. 10). Frustules with a median excavation on each side; valves elliptical; length 1-710″.

E. britannica. Frustules not excavated; length 1-380″.

Bibl. Ehrenb. *Abh. Berl. Akad.* 1839, p. 125; Kützing, *Sp. Alg.* p. 191, *Bacillar.* pl. 21. fig. 21; Smith, *Brit. Diat.* ii. 25.

EUCERTYD'IUM, Ehr.—A genus of Polycystina.

E. ampulla (Pl. 31. fig. 25, front view; fig. 26, under view).

See Polycystina.

EUCHLANIDO'TA, Ehr.—A family of Rotatoria.

Char. Rotatory organ multiple, or divided into more than two lobes; a carapace present.

The carapace forms either a testa or a scutellum; various appendages are present, representing either straight bristles, curved bristles or hooks, minute horns—so-called respiratory tubes or antennæ,—and in one genus a frontal hood.

The eleven genera are thus distinguished:

Eyes absent; foot forked	*Lepadella* (*Diplax*).
Eyes present.	
Eye single (cervical).	
Foot styliform.	
Carapace depressed	*Monostyla.*
„ prismatic	*Mastigocerca.*
Foot forked.	
Carapace open beneath	*Euchlanis.*
„ closed beneath.	
Carapace with horns	*Salpina.*
„ without horns	*Dinocharis.*
Eyes two (frontal).	
Foot styliform	*Monocerca.*
„ forked.	
Carapace compressed or prismatic.	*Colurus.*
„ depressed or cylindrical.	
Head without a hood	*Metopidia.*
„ with a hood	*Stephanops.*
Eyes four; foot forked	*Squamella.*

Bibl. Ehrenb. *Infus.* p. 455.

EU'CHLANIS, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eye single, cervical; foot forked; carapace cleft or open on the ventral surface. Aquatic.

Ehrenberg describes six species, to which Gosse adds three.

E. triquetra (Pl. 34. fig. 30; fig. 31, teeth). Carapace very large, with a dorsal crest; foot without setæ; length 1-48″.

Bibl. Ehrenb. *Infus.* p. 461; Gosse, *Ann. Nat. Hist.* 1851, viii. p. 200.

EUCRAT'EA, Lamx. (*Scruparia*).—A genus of Cheilostomatous Infundibulate Polyzoa, of the family Eucratiadæ.

E. chelata (Pl. 44. fig. 18), the only species. Parasitic upon *Fuci*, crabs, and stones.

Bibl. See the family.

EUCRA'TIADÆ (Scrupariadæ). — A family of Cheilostomatous Infundibulate Polyzoa.

Distinguished by the unjointed polypidom, and the uniserial cells. Polypidom usually loosely adnate. Four genera:

Eucratea (*Scruparia*). Erect, branched, branches arising from the horn-shaped cells above or below the oblique orifice.

Hippothoa. Creeping, adherent, irregularly branched or netted, branches arising from the sides of the cells.

Salpingia (Pl. 44. fig. 25). Erect, branched; cells elongated, with trumpet-shaped processes at the base, orifice oblique, lateral.

Anguinaria (*Ætea*). Cells tubular, scattered, arising from a creeping, adherent thread.

Beania. Cells erect, scattered, with a double spinous keel on one side, and arising from a creeping, adherent, branched thread.

Bibl. Johnston, *Brit. Zooph.* 288; Busk, *Mar. Polyz.* 28; Gosse, *Mar. Zool.* ii. 12.

EUCYTHE'RE, Brady (*Cytheropsis*,

Sars).—A genus of marine Entomostraca, fam. Cytheridæ.

2 species.

Bibl. Brady, *Linn. Trans.* 1868, p. 429.

EUDEN'DRIIDÆ (Tubulariidæ, pt., Johnst.).—A family of Hydroid Polypi. Characterized by the branched stem, the terminal naked polypes, with a single whorl of tentacles surrounding the base of a trumpet-shaped proboscis.

1 genus: *Eudendrium.*

EUDEN'DRIUM, Ehr.—A genus of Hydroid Polypi, fam. Eudendriidæ (Tubulariidæ, Johnst.).

Char. Those of the family.

7 British species.

E. ramosum (*Tubularia ram.*, Johnst.) is common on oyster-shells &c.

Bibl. Hincks, *Brit. Zooph.* 79; Johnstone, *Brit. Zooph.* 46.

EUDORI'NA. See Pandorina.

EUGLE'NA, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. Unattached; a red eye-speck, a tail-like process, and a single flagelliform filament.

Many species, or rather forms, are distinguished by Ehrenberg and Dujardin. They are often present in vast numbers in pools, &c., rendering them green or red, and forming a brilliant pellicle upon the surface.

In the free condition, the *Euglenæ* swim about in the water, not apparently by the help of the flagelliform filament, which seems to be often deficient, but by the contractile action of the whole body, the changes of form and movements of which may be roughly compared to those of a leech when crawling sluggishly over the surface of a glass. The *Euglenæ* present many points of resemblance to the lower Algæ, especially *Protococcus*, like them varying in colour from green to red, and, moreover, passing through a resting stage, encysted in a kind of cell-membrane, which is sometimes gelatinous, transparent, and spherical, sometimes rather horny, and polygonal in form. The encysted forms occur commonly aggregated together into indefinite frond-like masses; and the individuals multiply by division into two, four, &c., in this quiescent stage. The frond-like groups may be found in autumn, and even under the ice in winter, while the active forms abound most in spring, in fine weather. These organisms require further investigation, for the settlement of the specific characters and the relations to their congeners. Carter has published some elaborate observations on the organization of these and allied forms, which we have not space to enter upon here. (See Astasiæa.) We can only notice two or three of the forms.

E. pyrum (Pl. 24. fig. 1). Body, when extended, oval, turgid, pyriform, obliquely furrowed, green; tail nearly as long as the body, acute. Aquatic; length 1-1150 to 1-860″.

E. viridis (Pl. 24. fig. 2 *a*, *b*). Fusiform when extended; head narrowed, short; tail conical, short (not cleft); green, hyaline at the ends. Aquatic; length 1-1150 to 1-240″.

E. longicauda, *Phacus longic.* D. (Pl. 24. figs. 3 & 63). Depressed, elliptical or oval, frequently twisted on its long axis, green, with longitudinal striæ; tail as long as the body, hyaline, subulate. Aquatic; length 1-280 to 1-120″.

E. acus (Pl. 24. fig. 4). Fusiform, slender, subulate, straight, green in the middle; head attenuate, somewhat truncate, hyaline; tail very acute, hyaline. Aquatic; length 1-570 to 1-216″.

Bibl. Ehrenb. *Infus.* p. 104; Dujardin, *Infus.* p. 358; Morren, *Rubéf. d. Eaux.* Brux. 1841; Carter, *Ann. N. Hist.* 1856, xviii. p. 115, and 1857, xx. p. 21

EUGLE'NIA, Duj. (Infusoria). See Astasiæa.

The essential character of this family is the presence of a contractile integument; this is probably of little importance, as in many cases the nature of the integument has been shown to depend upon season, locality, and stage of development.

EU'GLYPHA, Duj.—A genus of Rhizopoda.

Char. Free; single; carapace membranous, transparent, resisting, elongato-ovoid, urceolate, covered with rows of tubercles or depressions; orifice toothed; expansions numerous, simple.

This genus appears unnecessarily separated from *Difflugia*, E.

E. tuberculata (Pl. 23. fig. 53). Carapace covered with oblique or longitudinal rows of rounded tubercles. Aquatic; length 1-280″. Sometimes posterior spines are present.

E. alveolata (Pl. 23. fig. 54). Carapace covered with polygonal depressions, in regular oblique rows. Aquatic; length 1-280″. Posterior spines also present.

See Difflugia.

Bibl. Dujard. *Infus.* p. 251; Carter, *Ann. N. Hist.* 1865, xv. p. 290.

EUMERID'ION, Kütz. — Consolidated with MERIDION.

EUNO'TIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules free, single or binate, quadrilateral; linear or linear-oblong in front view, curved or concavo-convex in side view; valves with terminal puncta (nodules ?) and transverse or slightly radiating striæ, but no canaliculi. Aquatic and fossil. Allied to *Epithemia*.

Many of the species have undulations or ridges upon the convex surfaces; striæ resolvable into dots, but in some species difficult to detect; transverse section of frustule trapezoidal.

Kützing describes forty-four species; Smith admits seven as British.

E. tetraodon (*Himantidium tetr.*, K.) (Pl. 42. fig. 27: *a*, side view; *b*, front view). Frustules with four ridges; striæ distinct; length 1-570″.

E. monodon (*Himant. monodon*, K.). Side view lunate, no ridges, slightly constricted near the obtuse ends; striæ obscure; length 1-800″.

E. triodon. Ridges three; ends attenuate, rounded; striæ obscure; length 1-500″.

BIBL. Kützing, *Bacill.* p. 36, and *Sp. Alg.* p. 4; Smith, *Brit. Diat.* i. p. 15; Ralfs, *Ann. N. H.* 1844, xiii. p. 459.

EUNOTOGRAMMA, Weisse.—A genus of fossil Diatomaceæ.

Char. Front view as in *Anaulus*; side view lunate, with undulated dorsal and ventral margins.

E. tri-, quinque-, septem-, et novemloculata. Side view divided by 2, 4, 6, or 8 transverse septa into 3, 5, 7, or 9 loculi. Russia.

BIBL. Pritchard, *Infus.* p. 860; Weisse, *Bull. d. St. Pétersbourg*, xiii. p. 278.

EUODIA, Bailey.—A genus of Diatomaceæ.

Char. Frustules areolar or granular, side view lunate.

3 species: 2 fossil, 1 recent. Perhaps *Goniothecia*.

BIBL. Bailey, Pritchard's *Infus.* p. 852; Greville, *Micr. Trans.* 1861, p. 67.

EUPLEURIA, Arn.—A genus of Diatomaceæ.

3 species: New Zealand and Africa (Ichaboe guano).

BIBL. Arnott, *Qu. Mic. Jn.* 1858, vi. p. 89.

EUPLO'TA, Ehr.—A family of Infusoria.

Char. Body surrounded by a carapace; two distinct alimentary orifices, neither of which is terminal (=Oxytrichina with a carapace).

Locomotive organs consisting of cilia, hooks, claws, or styles. Dujardin states that the carapace undergoes diffluence like the substance of the body.

The genera are thus distinguished:—

Cilia, claws, or hooks, present; no styles.	Mouth without teeth	Head distinct	*Discocephalus.*
		No distinct head	*Himantophorus.*
	Mouth with teeth		*Chlamidodon.*
Cilia, claws, and styles present			*Euplotes.*

Dujardin includes this family in his Plœsconina.

BIBL. Ehrenb. *Infus.* p. 374; Dujard. *Infus.* p. 429.

EUPLO'TES, Ehr. (*Plœsconia*, Duj. for the most part).—A genus of Infusoria, of the family Euplota, E.

Char. Furnished with cilia, styles, and hooks; teeth absent.

The species are very numerous.

E. patella, E. (*Plœsconia pat.*, D.) (Pl. 24. fig. 5: *a*, under view; *b*, side view). Carapace a testa, oval or suborbicular, slightly truncated in front, margins extending beyond the depressed body; dorsum raised or bossed with fine radiating striæ; cilia forming a curvilinear series. Aquatic; length 1-288 to 1-216″.

E. cimex, E. (*Coccudina cimex*, D.).

E. charon, E. (*Plœsconia charon*, D.).

E. vannus, E. (*Pl. vannus*, D.) (Pl. 24. fig. 6).

E. monosty'lus, E. (*Ervilia legumen*, D.) (Pl. 23. fig. 52).

BIBL. Ehrenb. *Infus.* p. 377; Duj. *Infus.* p. 435; Stein, *Infus.* p. 158.

EUPODIS'CUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, disk-shaped, circular, without internal septa; valves furnished with tubular or spiniform processes. Marine and fossil.

The processes are so easily broken off, that the apertures corresponding to the points of attachment are generally alone seen. The valves appear either distinctly areolar, the depressions being large; granular, from their being minute; or striated.

Two groups are recognizable:

a. Eupodiscus proper. Valves areolar or striated.

E. argus (Pl. 12. fig. 30: *a*, side view; *b*, front view). Valves slightly convex; processes three; diameter 1-156″.

E. sculptus, Sm. (Pl. 12. fig. 31). Valves striated, central striæ forming a quatrefoil; processes two; diameter 1-770 to 1-400″.

b. Aulacodiscus, E. Valves granular; processes very short, their bases connected with the centre of the valve by a furrow.

E. crux (Pl. 41. fig. 43). Diameter 1-380″.

E. Petersii. Processes four, with larger granules at their bases. Diameter 1-380″.

Bibl. Ehrenb. *Ahh. Berl.* 1839; id. *Ber.* 1844, p. 73, 1845, p. 361; Smith, *Brit. Diat.* i. p. 24; Kützing, *Sp. Alg.* p. 134; Shadbolt, *Qu. Mic. Jn.* ii.; Roper, 1858, *ibid.* vi.; Greville, *Mic. Trans.* 1863, 73, (*Aulacodiscus*) 1864, pp. 9, 82, 87, 1865, p. 26, 1866, pp. 5, 80.

EUPOTIUM.—A genus of Marattiaceous Ferns. Exotic.

EUROTIUM, Lk.—A genus of Mucorini (Hyphomycetous Fungi), on the distinct nature of which great doubt is thrown by the recent observations of De Bary. *E. herbariorum* of authors is a mildew, common upon preserved fruits, forming a whitish or yellow crust, composed of interwoven mycelium filaments, which are delicate when young, but become thickened and often coloured with age. Upon these are produced globular *conceptacles* or peridia, from 1-15 to 1-20‴ in diameter, composed of a distinctly cellular membrane, enclosing little sacs or *asci* containing several minute sporidia. According to De Bary, these conceptacles are produced upon the mycelium of *Aspergillus*, under certain unknown conditions, and the ordinary fructification of *Aspergillus* is only a basidiosporous form of the same plant which produces an ascophorous form in the *Eurotium* fruit. He states that he not only found them growing upon the continuations of the same branched mycelium filament, but that he has raised *Aspergillus*, which fruited, from the spores both of *Aspergillus* fruits and the sporidia of *Eurotium.* He was unable to obtain *Eurotium* from *Aspergillus* spores. The connexion between these forms is regarded by him as analogous to that between *Oidium* and *Erysiphe*; but the conceptacles of *Eurotium* do not originate in the same way as those of *Erysiphe* from the mycelium filaments. According to his elaborate account, the production of the fruit of *Eurotium* takes place in a most remarkable manner. The ends of the branches of the mycelium coil up like a cork-screw, becoming more closely approximated, until at length they come into contact, and form a cylindrical or conical mass, marked externally by the spiral lines of conjunction of the turns of the filament. The mode of transformation into the cellular conceptacle could not be traced in its minute details; but all possible stages were found upon the same mycelium, between the loose spiral coil and the globular sac, composed of a distinctly cellular membrane, in the cavity of which became developed the asci or parent cells of the sporidia. The ripe *sporidia* often exhibit a curious form, like little cylinders with a concavo-convex cap applied over each end: these appear to be the two halves of the dehiscent outer membrane (*exospore*); for in the germination of perfectly globular forms the mycelium filaments break through the outer tough coat, like a pollen-tube from the inner coat of a pollen-grain. The sporidia are about 1-350‴ in diameter, and of a light yellow colour in mass. The dimensions &c. of *Eurotium*, like those of *Aspergillus*, seem to vary with the external conditions.

The above curious phenomena deserve more investigation, which may readily be made by a practised microscopist, since the materials are everywhere at hand, on decaying fruits, mildewed preserves, or plants imperfectly dried for herbaria, &c.

Eurotium Rosarum, Greville (*Sc. Crypt. Fl.*) = *Sphærotheca pannosa.*

Bibl. Berk. in Hook. *Brit. Fl.* ii. pt. 2. p. 333; Greville, *Scot. Crypt. Fl.* pl. 164. fig. 1; Sowerby (*Farinaria*), pl. 379. fig. 3; De Bary, *Bot. Zeit.* xii. p. 425 (1854); Riess, *ibid.* xi. p. 134, and Fresenius, p. 474 (1853).

EURYCERCUS, Baird (*Lynceus*, in part, Müll.).—A genus of Entomostraca, of the order Cladocera, and family Lynceidæ.

Char. Subquadrangular (in side view); abdomen very broad, flattened, densely serrated; beak blunt, slightly curved downwards. Aquatic.

E. lamellatus (Pl. 15. fig. 39). Shell olive, ciliated on the anterior ventricose margin, arched behind; beak rather blunt and short; superior antennæ terminating in six short spines, each with a fine seta or bristle; anterior branch of inferior antennæ with five long filaments—one from the end of the first and second joints, three from the third, as also a small spine; posterior branch with three long filaments at the end of the last joint, the first and second each with a short spine only.

It generally lives at the bottom of the vessel in which it is kept.

Bibl. Baird, *Brit. Entom.* p. 123.

EVADNE, Lovén.—A genus of Entom-

ostraca, of the order Cladocera, and family Polyphemidæ.

Char. Abdomen short, scarcely projecting from the shell; head not distinct from the body; marine.

E. Nordmanni (Pl. 14. fig. 30). Colourless, excepting the eye.

Forms part of the food of the herring.

Bibl. Lovén, *Wiegmann's Archiv*, 1838, Bd. i. p. 143; M.-Edwards, *Hist. Nat. d. Crustac.* iii. 390; Baird, *Brit. Entom.* p. 114.

EVER'NIA, Ach.—A genus of Lichens, tribe Everniei; cosmopolitan in its range, recognized by its flattened, flaccid, laciniate, white or grey thallus, lateral apothecia, and simple spores. Two species: *E. furfuracea* (*E. Bot.* pl. 984) and *E. prunastri* (*E. Bot.* pls. 859 & 1353) occur in Great Britain.

Bibl. Nylander, *Syn.* p. 283; Leighton, *Lich. Fl. G. B.* p. 89.

EXCIP'ULA, Fr.—A genus of Sphæronemei (Coniomycetous Fungi), forming horny tubercles on dead stems and leaves, finally opening by an entire orbicular aperture. The *stylospores* are elongated, lanceolate or fusiform; and long hair-like processes are sometimes mixed with the sporophores which line the disk. Four British species are recorded: *E. fusispora* and *E. strigosa* of Fries, and *E. macrotricha* and *E. chætostroma* of Berk. and Br. Perhaps related to some Ascomycetous form. (See Coniomycetes.)

Bibl. Berk. in Hook. *Br. Fl.* ii. pt. 2. p. 296; Berk. and Broome, *Ann. Nat. Hist.* 1850, v. p. 456, pl. 11. fig. 2.

EXIDIA, Fr.—A genus of Tremellini (Hymenomycetous Fungi), forming gelatinous, truncated black or coloured bodies on the trunks and branches of trees. Common in autumn and winter. Tulasne has lately published some interesting observations on the structure of the hymenium which clothes the upper face. This is composed of a densish layer of very slender filaments, which bear at their free surface globular cells (*basidia*) divided vertically into two or four chambers; from each of these arises a slender process (*sterigma*), at the end of which is developed a *stylospore*. In *E. spiculosa*, *spermatia* were also observed in young specimens, at the ends of very slender filaments passing through the mucilaginous layer overlying the layer of *basidia*. (See Dacrymyces, Hirneola, and other genera of Tremellini.)

Bibl. Berk. in Hook. *Br. Fl.* ii. pt. 2. p. 217; Tulasne, *Ann. des Sc. Nat.* 3 sér. xix. p. 202, pls. 11 & 12.

EXOCOCCUS, Nägeli.—Probably a *Protococcus* or *Palmella*.

Bibl. Nägeli, *Neu. Algensyst.* p. 169.

EXOGEN. See Dicotyledons.

EXOSMOSE. See Endosmose.

EXPECTORATION.—The various objects which may be found in the expectoration are noticed under their respective heads, or those of the tissues from which they are derived; a list only need be given here.

Mucous corpuscles, *i. e.* young epithelial cells; mature epithelial cells, of the pavement, cylinder, or ciliated forms; exudation globules, or granule-cells; pus and pyoid corpuscles; coloured corpuscles of the blood; pseudo-membranous flakes of fibrine; tubercle; fatty matter in the form of globules, rarely of crystals; earthy matters, amorphous or crystalline; various substances derived from the food, as muscular fibre, starch-granules, cellular tissue, &c.; entozoa, or fragments of them, as portions of the cysts or hooks of *Echinococcus*; infusoria and algæ, as Monads, *Bacteria*, *Sarcina*, &c.; carbon and true pigment, either in the free state or contained within epithelial cells; and fragments of pulmonary tissue.

The aid of the microscope in the examination of the expectoration will occasionally throw an unexpected light upon the diagnosis of disease. And it has lately been shown, that by boiling the sputa with solution of caustic soda and washing, the pulmonary fibrous tissue may often be detected in Phthisis.

EXUDATION, and EXUDATION CORPUSCLES. See Inflammation.

EXU'VIUM (exuvia; or exuviæ, plur.).—The cast or shed skin of animals. The exuvium of many minute animals exhibits the form and structure of the skin, and the parts upon which it is moulded, better than these can be discerned in the living animals, on account of its transparence. The exuvium of the Triton (Pl. 40. fig. 12) exhibits the cellular structure of the epidermis very beautifully.

EYE.—From want of space, we are compelled to assume that the reader possesses a knowledge of the component parts of the eye and their relative position, as far as can be obtained without the use of magnifying glasses. These parts are generally described in works upon anatomy, and in most of those upon optics.

The outer fibrous coat of the eye is com-

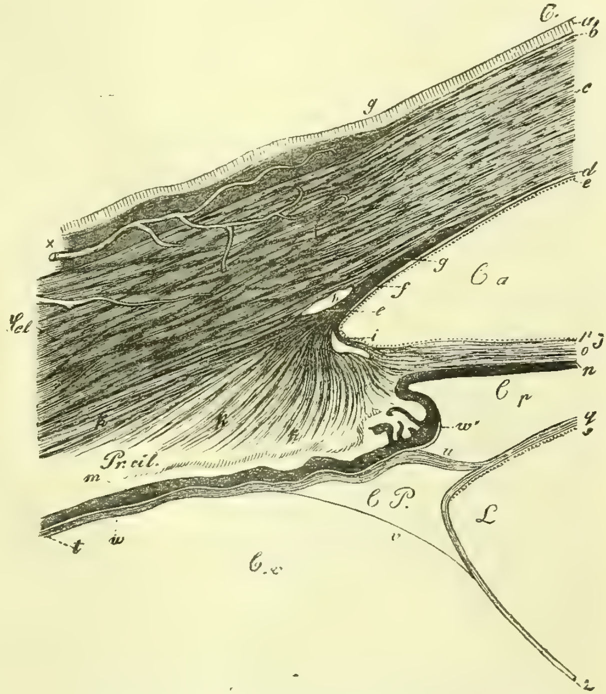
monly regarded as consisting of two parts: one anterior, smaller and transparent—the cornea; the other, posterior, larger and opaque—the sclerotica. The history of the development and the minute structure of these prove that they must be considered as forming a single continuous membrane.

The *sclerotica* (fig. 207. *Scl.*) or *tunica albuginea* covers the posterior four fifths of the ball of the eye; it is a milk-white, very firm, fibrous membrane, continuous posteriorly with the sheath of the optic nerve, becoming gradually thinner in front, except at its termination, where the tendons of the recti muscles become fused with it. It consists of areolar tissue, the bundles of which are mostly straight, intimately united as in the tendons, forming alternating, longitudinal and transverse layers of various breadth and thickness. Mingled with the areolar tissue are numerous fine elastic fibres, in the form of a network, with thickenings which indicate the remains of the nuclei of the formative cells; these, in the inner portions, contain pigment. During life, the elements of this network, in parts, appear to involve canals with liquid contents; so that, when dried, they contain air.

The *cornea* may be regarded as consisting of three layers:—1, the corneal conjunctiva; 2, the true cornea; and 3, the membrane of the aqueous humour.

The *true cornea* (fig. 207 *c*), which forms the principal part of the membrane, consists of a substance nearly allied to areolar tissue. Its elements are pale bundles from 1-6000 to 1-3000″ in diameter, with still finer fibrillæ, united to form larger flat bundles, the surfaces of which are parallel to that of the cornea; these are connected with the bundles before and behind, so as to form a coarse reticular tissue. Between the bundles are a large number of anastomosing, fusiform, and stellate nucleated cells of imperfectly developed elastic tissue. The cells undergo fatty degeneration, partly forming the *arcus senilis*; and they sometimes contain pigment.

Fig. 207.



Section of the membranes of the eye, near the ciliary processes.

Scl., sclerotica; *C*, cornea; *Pr. cil.*, ciliary process; *Ca*, anterior chamber; *Cp*, posterior chamber; *Cv*, vitreous humour; *C.P.*, canal of Petit; *L*, lens; *I*, iris; *a*, conjunctiva of the cornea—epithelial layer; *b*, subjacent elastic layer; *c*, fibrous layer of the cornea; *d*, membrane of the aqueous humour; *e*, its epithelium; *f*, end of the membrane and its fusion with the fibres *g*, which pass to the iris at *i*, forming the pectinate ligament; *h*, venous canal; *k*, ciliary ligament or muscle arising from the inner wall *l* of the venous canal; *m*, pigment-layer of ciliary processes; *n*, that of iris; *o*, fibrous layer of iris; *p*, its epithelium; *q*, anterior wall of capsule of lens; *s*, epithelium of capsule; *t*, anterior thickened portion of hyaloid membrane; *u*, zonule of Zinn, or anterior lamina of hyaloid membrane; *v*, posterior lamina of the same; *w*, colourless epithelium of the ciliary processes; *w′*, anterior end of this epithelium; *x*, conjunctiva of sclerotica; *z*, posterior wall of the capsule of the lens.

Magnified 12 diameters.

The *corneal conjunctiva* (fig. 207 *a b*) consists of laminated soft epithelium—the under layer of cells elongated and placed perpendicularly to the surface, the middle cells

rounded, those in the upper layer forming softer nucleated plates. Many of the latter are furnished with larger or smaller depressions, arising from mutual pressure, so as to appear stellate in the side view. Beneath the epithelium is a structureless layer, the anterior elastic membrane, consisting of the remains of the formerly vascular layer of the corneal conjunctiva.

The *membrane of the aqueous humour* (fig. 207 *d*) consists of an elastic, perfectly structureless membrane, somewhat loosely connected with the cornea, and an inner epithelial lining. Towards the circumference of the cornea, the membrane of the aqueous humour merges into a peculiar system of fibres, which commence near the margin of the cornea, at the anterior surface of the aqueous membrane (fig. 207 *g*) as an extended network of fine fibres, resembling elastic fibrillæ; this increases in thickness, and at the very margin of the cornea the aqueous membrane becomes lost in a tolerably dense network of these coarse fibres, which curve around the margin of the iris (fig. 207 *i*), some passing through the anterior chamber, and become fused with the anterior surface of this membrane and the ciliary ligament (or muscle). These fibres form the *pectinate ligament* of the iris, which is much more distinct in some animals (as the dog) than in man.

The epithelium of the aqueous membrane consists of a single layer of polygonal cells. These become smaller near the margin of the cornea, where the membrane terminates as a continuous layer; but isolated portions of elongated or spindle-shaped cells are continued over the pectinate ligament to the anterior surface of the iris.

The cornea yields chondrine on boiling, and not gelatine.

The *choroid membrane* contains a large number of blood-vessels, and abounds in pigment. Its anterior, smaller, and transverse portion forms the iris.

The posterior portion, or proper choroid membrane, is from 1-360 to 1-180″ in thickness, and extends from the entrance of the optic nerve to near the anterior margin of the sclerotica, where it becomes thicker, forming the ciliary body, whence it is continued into the iris. It is connected with the sclerotica by vessels and nerves, and by some of the pigment-cells of its outer layer being continued into the areolar tissue of the sclerotica. The *lamina fusca* of authors is constituted by a portion of the membrane thus left adherent when attempts are made to separate it from the sclerotica.

The choroid consists essentially of two parts:—an outer vascular and thicker layer, the proper choroid; and an inner deeply coloured layer, the *pigmentum nigrum.* The former may again be separated into three parts, although these are not really distinct:—1, an outer, brown, soft layer, which supports the ciliary nerves and long ciliary vessels, and contains anteriorly the ciliary ligament—the outer pigment layer; 2, a less highly coloured proper vascular layer, with the larger arteries and veins; and 3, a colourless delicate inner layer, containing an extremely copious capillary network—the choro-capillary membrane, which does not extend anteriorly beyond the margin of the retina. The stroma of the choroid proper consists of elastic tissue, in the form of very irregular spindle-shaped or stellate cells, from 1-1500 to 1-6000″ in length, either paler, or containing a large quantity of pigment, and anastomosing by numerous long and very slender processes (fig. 208). These cells are most distinct in the outer layer; whilst more internally, and especially in the choro-capillary membrane, they gradually pass into a homogeneous or slightly striated nucleated tissue, containing but little and ultimately no pigment.

Fig. 208.

Cells from the stroma of the choroid: *a*, containing pigment; *b*, fusiform cells without pigment; *c*, anastomosis of the former. Magn. 350 diams.

In some animals the choroid membrane contains muscular fibres.

Between the stroma and the pigmentum nigrum is a very thin elastic layer; this is either structureless, granular, or finely reticulated, and is comparable to a basement membrane.

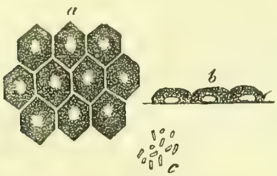
The *ciliary ligament*, or, properly, ciliary muscle—*tensor choroidæ* (fig. 207 *k*)—is composed of a tolerably thick layer of radiating unstriated muscular fibres; these, intermixed with pigment-cells of the choroid, pass from the anterior margin of the sclerotica to the ciliary body, and lose themselves in its anterior half, opposite the base of the ciliary processes. The fibre-cells are 1-600″ in

length, broader than most fibre-cells, and not easily isolated in man.

The *ciliary processes* consist of the same stroma as the choroid; but the stellate cells are more delicate and fewer, and, with the exception of those at their base, do not contain pigment; nor are they furnished with the elastic lamina.

The *pigmentum nigrum* (fig. 207 *m*) lines the inner surface of the choroid, and as far

Fig. 209.



Cells of the human pigmentum nigrum: *a*, surface view; *b*, side view; *c*, pigment-granules.

Magnified 350 diameters.

as the termination of the retina, consists of a single layer of beautiful, regularly six-sided cells (fig. 209 *a*, *b*), from 1-2000 to 1-1500″ in diameter; they contain abundance of pigment. Beyond the margin of the retina, the cells form mostly two layers, and become rounded and more loaded with pigment. The granules of pigment are very minute, rounded, from 1-20,000 to 1-30,000″ in diameter, and exhibit molecular motion. In the eyes of albinos, and in the region of the tapetum of animals, the cells contain no pigment.

The *iris* (fig. 207, I) consists of three layers:—an anterior epithelial layer; a posterior layer of pigment, called the *uvea*, and continued from the inner pigment layer of the choroid; and a middle, the thickest or fibrous layer.

The fibrous layer differs from the choroid, in containing areolar tissue forming delicate loose bundles, some of which pursue a radiating, others a circular course, and interlacing variously; in this tissue are a number of spindle-shaped or stellate cells, containing pigment, corresponding to those of the choroid; and in addition to numerous blood-vessels and nerves, two sets of muscular fibres: the latter in some animals are transversely striated; but in man they resemble the ordinary unstriped fibre-cells, and are 1-600 to 1-400″ in length. One set forms a sphincter for closing the pupil, its fibres taking a circular direction; the other set consists of bundles of radiating fibre-cells, traversing the stroma of the iris. The pigment layer or *uvea* consists of the same elements as those of the corresponding layer of the choroid.

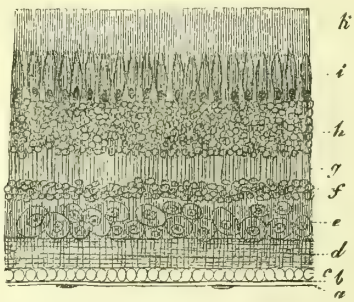
The anterior coat consists of a single layer of rounded, flattened epithelial cells.

The blood-vessels of the choroid membrane and ciliary processes are easily injected (*e. g.* in the sheep or ox) from the ciliary arteries, and form a magnificent object.

Retina.—The structure of the retina is so extremely complicated that we have not space to give more than a sketch of its component elements.

Eight layers are apparently present in a transverse section of the retina (fig. 210), excluding the hyaloid membrane, *a*: viz. 1, the layer of bacilli and cones (fig. 210 *k*, *i*); 2, an outer (*h*), 3, an intermediate (*g*), and 4, an inner (*f*) granular layer; 5, a layer of

Fig. 210.



Perpendicular section of a piece of the posterior part of the human retina.

a, hyaloid membrane with nuclei; *b*, limiting membrane; *c*, ends of the radiating fibres, so altered as to present a cellular appearance; *d*, expansion of the optic nerve; *e*, layer of nerve-cells; *f*, inner granular layer; *g*, intermediate or finely granular layer, in which the radiating fibres are more distinct than elsewhere; *h*, outer granular layer; *i*, inner division of the layer of bacilli, with the cones; *k*, outer division, with the processes of the cones and the true bacilli.

Magnified 250 diameters.

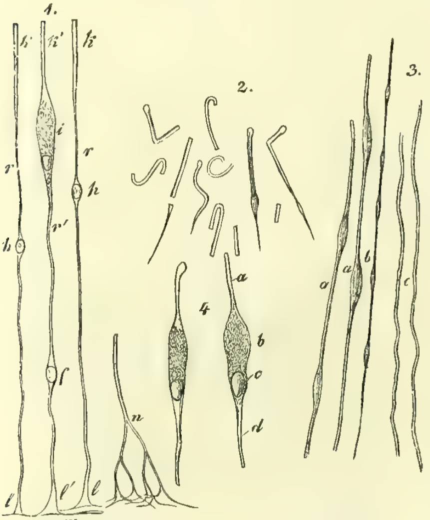
nerve-cells (*e*); 6, the expansion of the optic nerve (*d*); 7, the inner ends of the radial fibres (*c*); and 8, the limiting membrane (*b*).

The limiting membrane (*b*) is an extremely delicate structureless film, covering the inner surface of the retina, including the entrance of the optic nerve, and the *punctum aureum*.

The expansion of the optic nerve forms a membranous layer of extremely delicate transversely radiating fibrils (fig. 211, 3), from 1-24,000 to 1-12,000″ in diameter, and

mostly exhibiting varicosities. They contain no nuclei in their course, nor do they appear to contain axial fibres. They are aggregated into flattened bundles, which either run parallel or anastomose with each other. They appear to terminate in, or rather to arise from the nerve-cells of the retina, and are absent, or at least as a coherent layer, opposite the punctum aureum.

Fig. 211.



Elements of the human retina. 1. Radial fibres with bacilli: *k*, bacillus, connected with the fibre (*r*) by its inner acute end; *h*, nucleated expansion (cell), appearing in the outer granular layer; *l*, expanded end of the fibre, resting upon the limiting membrane *m*; *k'*, a bacillus connected with a cone *i*; *r'*, fibre running from the cone to the cell *f* of the inner granular layer; *n*, branched termination of a radial fibre, often present. 2. Bacilli separated from the fibres, broken and curved, &c. 3. Fibrils from the expansion of the human optic nerve: *a a*, larger, *b*, smaller, fibrils with varicosities; *c*, undulating pale fibres belonging probably to the proper radiating system. 4. Two cones connected with bacilli, and fragments of the fibres remaining: *a*, bacillus; *b*, cone; *c*, nucleus of cone.

Magnified 350 diameters.

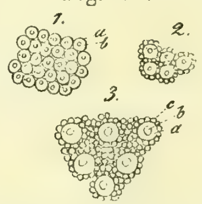
The layer of nerve-cells (*e*) consists of ordinary nerve-cells, pyriform, roundish, or angular, with pale processes; they vary in diameter from 1-3000 to 1-750″.

The remainder of the retina is composed of a very large number of parallel, very slender (1-60,000 to 1-20,000″ diameter), highly refractive, radiating fibres or tubes, with their axes at right angles to the surface of the choroid, upon which their outer ends rest, whilst their inner, triangular or branched extremities are in contact with the limiting membrane. They produce the striated appearance presented by a section of the retina (fig. 210). They are furnished at certain parts of their course with expansions containing each a nucleus; and the fibres are very numerous. These nucleated expansions being opposite each other, or in the same planes, give rise to the appearance of distinct granular layers mentioned above. The more internal nucleated expansions are connected with the nerve-cells of the retina by minute nerve-tubes.

Their outer portions have been distinguished as the *bacilli* and *cones*; but the whole probably form one continuous system of nerve-cells and tubes.

The *bacilli*, regarded (fig. 211 1 *k k'*, 2) as distinct bodies, are cylindrical, narrow and elongated, of the same breadth throughout, truncated externally, and terminating internally in a more slender portion of the fibre; they are from 1-430 to 1-330″ in length and 1-15,000″ in breadth; near the point of attachment to the fibre is a transverse line. They are extremely delicate, and easily broken or deformed. The cones (fig. 211 1 *i*, 4 *b*) are bacilli with a conical or pyriform body, and are also very easily injured. A slight constriction divides each cone into two parts, the innermost of which (fig. 211 4 *c*) contains a nucleus. The cones are from 1-6000 to 1-4000″ in diameter. In most parts of the retina the cones are surrounded by several bacilli; opposite the punctum aureum, they alone form a continuous layer; whilst at its margins, single bacilli intervene between the cones (fig. 212).

Fig. 212.



End view of the rows of bacilli and cones from the outside. 1, opposite the punctum aureum (cones only); 2, at its margins; 3, at the middle of the retina. *a*, cones or spaces corresponding to them; *b*, bacilli of the cones, the ends of which are often situated somewhat beneath the level of those of the true bacilli, *c*.

Magnified 350 diameters.

Opposite the entrance of the optic nerve, both bacilli and cones are absent. These curious bodies are more distinctly seen in

many animals than in man (Pl. 41. fig. 5).

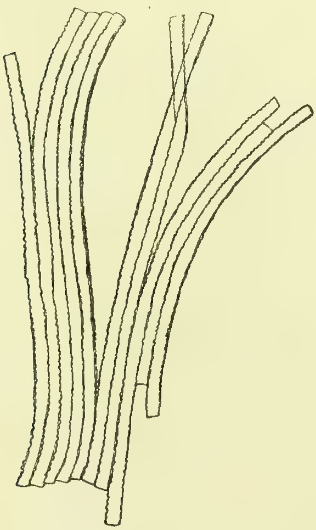
The radial system of fibres pass between the nerve-cells of the retina and the meshes of the optic nerve, to reach the limiting membrane. The inner ends of the fibres next the latter membrane, when overlapping each other, and especially when swollen by the action of water, present the appearance of a number of rounded or angular cells (fig. 210, *c*), for which they were once mistaken.

It is thus evident that, excepting the layer of nerve-cells and that of the fibres of the optic nerves, the retina cannot truly be considered as composed of layers. The series of bacilli and cones, when torn from their connexion with the radial fibres, form the so-called *Jacob's membrane.*

We cannot enter into the physiology of these radial fibres, which have been shown to be the percipients of light.

Crystalline lens, or simply, *crystalline.*—The crystalline lens is contained in a capsule (fig. 207 *q s*), consisting of a perfectly structureless, very elastic membrane, the anterior half of which is lined with a single layer of very transparent, polygonal, epithelial cells (fig. 207, *s*), from 1-2000 to 1-1200″ in diameter.

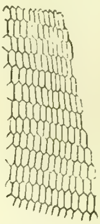
Fig. 213.



Fibres or tubes of the lens of the ox.
Magnified 350 diameters.

The lens itself consists of long, transparent, six-sided, flattened fibres (fig. 213), from 1-4800 to 1-2400″ in breadth and 1-8500 to 1-1300″ in thickness; these are tubular, at least in the outer portions of the lens, and contain a tenacious sarcodic substance, which escapes from the ends of the broken fibres in irregular globules. The form of the fibres is best seen in a transverse section (fig. 214).

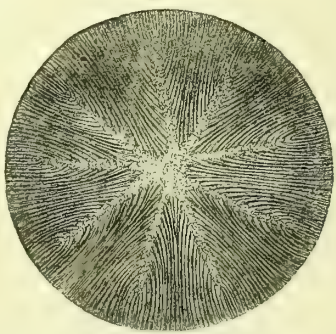
Fig. 214.



Transverse section of the fibres or tubes of the human lens.
Magnified 350 diameters.

The fibres are firmer, narrower, and more highly refractive towards the centre of the lens. Their general arrangement is such that their broad surfaces are parallel with the surface of the lens, and that they follow a direction from the middle of the anterior to that of the posterior surface, curving laterally in their course—not, however, exactly from the middle, but from the arms of a star-shaped kind of cèntre, at which parts (figs. 215, 216) the fibres are

Fig. 215.

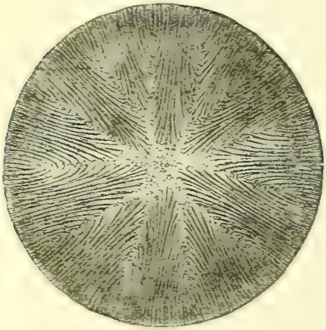


Anterior view of human crystalline lens (adult) showing the stars and the direction of the fibres.
Magnified 5 diameters.

replaced by a homogeneous or finely granular matter. The arms of the star present

upon the surfaces are the extremities of planes extending through the substance of the lens, from which the inner fibres take their origin. The arms of the anterior and

Fig. 216.



Posterior view of lens.
Magnified 5 diameters.

posterior stars are not parallel with each other; nor are the fibres arising from any part of the arm of one cross inserted into the corresponding part of the arm of the opposite cross. Great variety exists in different animals in the structure and arrangement of these stars and planes. Thus in the human fœtus the star has three arms or planes, whilst in the adult there are from nine to sixteen, of which three are frequently more distinct than the others. In some animals they are replaced by a pole, from which the fibres radiate like meridians, as in the cod, the *Triton*, and *Salamandra*; in others, there is a single plane, as in some fishes, the frog, the hare, the rabbit, and the dolphin; whilst in most of the mammalia there are three, and in the whale, the bear, and the elephant there are four.

The edges and marginal surfaces of the fibres of the lens are uneven or toothed, so that their lateral connexion becomes more intimate; hence the lens separates more readily into parallel laminæ in the direction of the surface than in the opposite direction.

In many animals, especially fishes, as the cod, the roach, &c., the irregularities of the fibres of the lens are replaced by beautiful teeth (Pl. 41. fig. 6).

Vitreous humour, or body, is enclosed in a membrane, the *hyaloid membrane*, which behind the dentate margin of the retina is extremely thin and delicate; anterior to this it becomes firmer (fig. 207 *t*) and passes, forming the *zonule of Zinn* to fuse with the capsule of the lens. In thus doing, it separates into two layers:—a posterior (*v*), which becomes consolidated with the capsule of the lens somewhat behind its margin; and an anterior (*u*), connected with the ciliary processes, which becomes attached to the capsule of the lens a little in front of its circumference: between these two is the *canal of Petit* (*C.P.*). The structure of the vitreous body is still obscure.

The structure of the eye is very difficult of examination, the parts being so delicate and easily injured. Many of them can be made out by dissecting the eye under water; but the more delicate structures should be immersed in the liquid of the anterior chamber: solution of chromic acid is useful for hardening the parts to allow of sections being made with a Valentin's knife. The lens should be hardened, either by maceration in solution of chromic acid, or by drying. The fibres may be well preserved in the dry state.

The structure of the eyes of the lower animals is briefly noticed under the classes, &c. In the mammalia generally, it is essentially the same as in man; and the eye of the ox or sheep may be selected for examination.

Bibl. Kölliker, *Mikr. Anat.*; Todd and Bowman's *Physiol. of Man*; Müller, H., *Comptes Rendus*, 1856, p. 743 (*Ann. N. Hist.* 1856, xviii. p. 492); Nunneley, *Qu. Micr. Jn.* 1858, 136; Schultze, *Anat. und Phys. d. Retina* (8 pl.), 1867; Hulke, *Histolog. of*, *Monthly Mic. Jn.* ii. 227; Lawson, *Ciliary Muscle of Birds*, *ibid.* ii. 204; Frey, *Histol.* 1870, and the full literature therein.

EYLAÏS, Latr.—A genus of Arachnida, of the order Acarina, and family Hydrachnea.

Char. Palpi longish, fourth joint longest, the fifth obtuse, somewhat tumid, spinous; mandibles unguiculate; rostrum very short, mouth round; body depressed; two approximate pairs of eyes; coxæ comparatively narrow, the fourth only in contact with the third at its base.

E. extendens (Pl. 2. fig. 28). Skin soft, furrowed, with the ramified alimentary canal visible through its substance. Between the two anterior coxæ (*d*) is seen the bilobed labium (*a*), the posterior portion containing the round and ciliated mouth, the anterior portion forming a kind of hood; palpi (*b*) with the three first joints very short; mandible consisting of a long thick joint, with

a thick mobile claw (*c*). Fig. 28 *d*, under surface of body, exhibiting from before backwards:—the mouth, with the hood, and the palpi; next two groups of anterior coxæ; the vulva and two stigmata; the four posterior coxæ; and lastly, the anus in the middle, with a stigma on each side.

The larvæ are hexapod, reddish, pellucid, with the eyes four, wide apart.

E. confinis, K.

E. atomaria, K.

Bibl. Dugès, *Ann. d. Sc. Nat.* 2 sér. i. p. 156; Gervais, *Walcken. Arachnid.* iii. p. 207; Koch, *Deutschl. Crustac.*

F.

FABULARIA, Defrance.—A porcellaneous Foraminifer, growing like a *Biloculina*, but having its chambers filled with labyrinthic shell-matter, the cavities in which are mostly elongate with the axis of the shell. They are narrow, and, opening terminally, make a cribriform septal face.

Quinqueloculina saxorum has thickenings within, making internal grooves and ridges, thus verging on the Fabularian type; and *Hauerina* has a cribriform septal plate, but without superadded internal structure.

Fabularia ovata (De Roissy), known also as *F. discolithus* of Defrance, abundant in the Eocene Tertiaries of France, is the only known species.

Bibl. Carpenter, *Introd. Foram.* 82.

FADYE'NIA, Hook.—A genus of Polypodieæ (Polypodioid Ferns). Exotic.

FÆCES.—We shall not dwell upon the nature of the objects contained in the fæces; suffice it to say that they may consist of:—the elements of the various secretions poured into the intestinal canal; the products of inflammation; undigested remains of articles of food, or bodies taken with the food or drink; and entozoa. Some of these resemble others very closely to the naked eye. The use of chemical reagents should never be omitted in their examination.

Bibl. See Chemistry, Animal.

FASCIÆ.—The fasciæ consist of the same elements as Areolar Tissue, and present all the varieties of arrangement intermediate between it and Tendon.

FATTY DEGENERATION. See Degeneration, Fatty.

FATTY TISSUE, or Adipose Tissue.—This is formed of colourless cells, with a very delicate, transparent, structureless cell-wall, enclosing, in the normal state, globules of yellowish fat (Pl. 40. fig. 41). The cells generally occur in groups, surrounded by or imbedded in areolar tissue. They are rounded when isolated, or polygonal when aggregated, and from 1-800 to 1-300″ in diameter; and the fat so fills them, that neither the nucleus which they contain nor the cell-wall is visible. The fat may be removed by drying them, and digesting with ether, when the cells appear contracted and wrinkled. In emaciated and dropsical subjects, each cell contains a number of small globules of fat, frequently of a reddish colour (Pl. 30. fig. 3), together with serum, and the nucleus is very distinct. Sometimes in these cases the cells are somewhat spindle-shaped or stellate. The fat contained in the cells is ordinarily in a liquid state; but sometimes the margarine separates in the crystalline form (Pl. 7. fig. 15 *a*).

In the mammalia generally the fatty tissue occurs in the same localities, and has the same structure, as in man. In fishes, the fatty matter is deposited principally in the liver. In reptiles, it occurs chiefly in the abdomen; thus in the frog and toad it forms long appendages occupying the sides of the spine. In birds, it exists chiefly between the peritoneum and the abdominal muscles, and in some of the bones. In many of the lower animals it appears to exist in the state of solution only.

Fatty matter may be deposited in cells of all kinds, as in fatty degeneration. During the development of cells, it exists in solution. The action of solution of potash is often of service in distinguishing globules of sarcode, which have a high refractive power, and much resemble those of fat, from this substance, as it dissolves the former, but not the latter.

Bibl. Todd and Bowman, *Phys. of Man*; Kölliker, *Mikr. Anat.*

FAUJASINA, D'Orb.—A delicate and handsome Foraminifer, but not typical.

F. carinata, D'Orb., found in the Maestricht Chalk, is a thin asymmetrical (plano-convex) *Polystomella*, somewhat thinner or flatter than *P. macella* (F. & M.), which is a subcomplanate, perhaps starved, variety of *P. crispa* (Linn.).

Bibl. Parker and Jones, *Ann. N. H.* 3 ser. v. 104; Carpenter, *Introd.* 213, 286.

FAVEL'LA.—A form of the conceptacular fruit of the Florideous Algæ, where the spores are collected in spherical masses situated wholly upon the external surface

of the frond, as in *Ceramium* and *Callithamnion*.

FAVELLID'IUM.—A form of the conceptacular fruit of the Florideous Algæ, where the spores are collected in spherical masses attached to the wall of the frond or imbedded in its substance, as in *Halymenia* and *Dumontia*. The term is usually extended to similar fruits not perfectly immersed, *e. g.* those of *Gigartina*, *Gelidium*, &c., where they form tubercles upon the branches. Sometimes these tubercles open by a pore on the surface, when mature, to emit the spores.

FA'VUS (Porrigo in part, Willan and Bateman).—A disease of the skin, characterized by the presence of cup-shaped isolated or aggregated crusts, consisting of a Fungus. (See ACHORION and PUCCINIA.)

FEATHERS OF BIRDS.—Feathers agree in all essential points of structure with the hairs of other animals.

Each feather is composed of a quill (containing the pith), a shaft, and a vane or beard with its barbs. The whole consists of a number of epidermic cells, often containing pigment, but in most parts so consolidated or fused together as to be imperceptible.

In the quill, the cells are flattened, elongated, and arranged with their long axis in the direction of that of the feather, and their nuclei have the same form as those of the corresponding part (cortex) of the human hair. The cells of the pith are often undistinguishable in old feathers, whilst in the younger ones they are very distinct, rounded or polygonal, and contain air. The shaft and the barbs exhibit the same cortical and medullary structure; the latter is often beautifully distinct (Pl. 17. figs. 14 & 15 *c*), and causes them to resemble closely the hairs of some Rodents. The barbs are sometimes furnished with secondary barbs, or barbules, resembling them in form, but differing mostly in the absence of the pith.

Feathers are developed in a capsule, and from a pulp or matrix, as in the case of hairs. Hence a feather may be regarded simply as a large, doubly or triply pinnate hair.

During development, the cell structure is very distinct; but in the mature feathers, digestion with solution of caustic potash is requisite to render this visible; and frequently even under these circumstances, the nuclei alone can be detected.

The barbs of some feathers resemble the shafts, being rounded or angular, and free or unattached (figs. 17 & 18); but in others they are flattened, and linked together in a remarkable manner, much resembling that met with in the wings of Hymenopterous and other Insects (Pl. 27. figs. 11 & 13), and which has been so often adduced as one of the many wonderful instances of design in the creation. Thus the upper or outer margin of each barb is fringed on both sides with hair-like elongated processes or pinnæ (Pl. 17. fig. 15 *a*, *b*), which differ in structure on the two sides. On one, and this always the same side of each barb (fig. 15 *b*), the pinnæ are toothed on one edge (fig. 16 *b**), whilst the pinnæ arising from the other side (fig. 15 *c*) exhibit, beyond the middle, a number of curved hooks (fig. 16 *a*), which clasp around the first kind existing upon the adjacent barb, so as to retain a firm hold upon them, this being aided by the teeth, which prevent them from slipping. If the relative position of the two sets of pinnæ which spring from two adjacent barbs be examined, it will be seen that they cross each other at a considerable angle, so that any pinna from one barb crosses several of those belonging to the next barb. Hence each pinna is connected by its hooks with several of those which it crosses; for the pinnæ with hooks are situated outside or above those not furnished with these appendages. The under or inner margin of each barb is simply membranous, and curved so as to overlap that of the next.

The free barbs of feathers are often met with in the examination of liquids &c. left exposed to the air (figs. 17 & 18).

BIBL. Schwann, *Mikrosk. Untersuch.*; Reclam, *De Plumar. Evolut. &c.*; Leydig, *Histologie*, 99; R. Beck, *Achr. Micr.* p. 31.

FEET.—In descriptions, &c., of the Articulata, especially of Insects, the word *feet* is mostly used to designate the legs; hence when met with in the works of systematic and other writers on these classes, it must be understood to mean the legs.

FEET OF INSECTS. See INSECTS, *Legs*.

FEGATEL'LA, Raddi (*Conocephalus*, Hill).—A genus of Marchantiaceous Hepaticæ. *F. conica* (*Marchantia conica*, Brit. Fl.), the only British species, is not uncommon, and is one of the largest of the tribe. It is distinguished from *Marchantia* by its nearly entire conical fertile receptacle. The dichotomously divided frond is of a yellowish-green colour. This genus is remarkable for the mode in which the pedicel

of the sporange becomes detached from the base of the epigone before the former bursts (fig. 220); the perigone holds the sporange firmly between its valves until empty, and then lets it fall out, together with its pedicel. Hence fully-developed sporanges are seldom found in dried specimens. (See MARCHANTIEÆ.)

Fig. 219. Fig. 220.

Fegatella conica.

Fig. 219. Vertical section of the upper part of a fertile receptacle, showing four of the sporanges surrounded by their perigones and epigones almost enclosed in the conical receptacle. Magnified 10 diams.

Fig. 220. A sporange just before bursting, enclosed in in its epigone; its pedicel detached at the base. Magn. 20 diams.

BIBL. Hooker, *Brit. Fl.* v. pt. 1. p. 107; Bischoff, *Nova Acta Ac. N. C.* xvii. 970, pl. 68; *Engl. Bot.* pl. 504.

FENESTRELLA, Grev.—A genus of Diatomaceæ.

Char. Frustules free disciform; disk with minute radiant dots, interrupted in the middle by a transverse band, composed of parallel lines of dots, band terminated at each end by a flat ocellus (nodule).

F. barbadensis. Barbadoes deposit.

BIBL. Greville, *Micr. Trans.* 1863, p. 67.

FERMENTATION. — The definition given by Mulder is:—a chemical action effected by certain substances and transferred to others, the primary substances being at the same time decomposed, though they do not communicate any of their elements to the new products. Under this name are understood various processes of decomposition of organic compounds, although it would be desirable to restrict it to those taking place with the cooperation of living organisms. The most familiar examples of the fermentation produced by the growth of living organisms, are those which convert saccharine infusions into spirit, vegetable juices into beer, wine, &c., or vinegar, and occur generally in watery solutions of vegetable substances containing saccharine matters or other ternary compounds with a certain amount of nitrogen; with these is included also the putrefactive fermentation of moist animal or other highly nitrogenous substances.

The vinous fermentation appears to depend entirely upon the growth of Yeast, a microscopic fungus, in the liquid (see YEAST); and the same plant is not only capable of producing the conversion of spirit into vinegar, but will also give rise to the peculiar fermentations of milk, tannic acid, &c. Much obscurity yet prevails upon this subject; but all investigations appear to tend in the direction of proving that these changes are absolutely dependent upon the agency of Fungi. The nature and characters of the fungoid productions are themselves but imperfectly understood; for the same species seems to present very different forms under different conditions of temperature and in different liquids, while it is very probable that the same changes may be produced in any given liquid by the growth of the mycelium of different kinds of Fungi. The Yeast-plant, as ordinarily known, appears so associated with *Penicillium*, that there seems no doubt as to the necessary relation between them. We find that beer, exposed to the air at ordinary summer temperatures, soon becomes coated with the minuter globules (conidia) of Yeast, forming a dry-looking whitish powder over the surface; and very soon after, *Penicillium glaucum* makes its appearance in fruit. Turpin found the same thing in milk. Again, the 'vinegar-plant,' as it is called, which converts solutions of sugar into vinegar, seems to be undoubtedly the mycelium of *Penicillium glaucum*, as it fructifies with the characters of this when the liquid is exhausted; but the gelatinous mass of mycelium contains, intermixed with the ordinary filaments of this genus, spherical and elliptical cells and chains of cells of all sizes, many of which are undistinguishable from the Yeast-plant, and the mycelium of *Oidium*. It must be recollected also, that the growth of true Yeast is favoured by a certain amount of heat, while the *Penicillium*-mycelium grows luxuriantly at ordinary temperatures.

The 'mother' of vinegar, which finally decomposes the acid, appears to be the same plant; and no satisfactory distinction can be drawn between this and those *mycelia* forming cloudy flocks in and decomposing various saline solutions, &c., described as species of *Hygrocrocis*, *Leptomitus*, &c. The

decay of wood, again, is often greatly accelerated by the growth of the mycelium of Fungi, which seems to decompose the organic compounds in the wood in the same way that the Yeast does those in organic liquids. A general law indeed appears to prevail throughout the Fungi, that their nutrition differs from that of all other plants in depending *exclusively* on the absorption and decomposition (with the evolution of carbonic acid) of organic compounds, therefore consisting of the performance of the operation of *fermentation* on the organic matters upon which they feed. Details upon the microscopic phenomena attending fermentation produced by Fungi will be found under YEAST, VINEGAR-PLANT, TORULA and PENICILLIUM, and PARASITIC FUNGI.

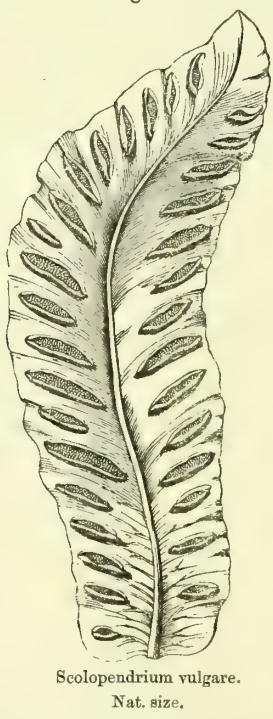
The fermentation of animal substances, and of vegetable substances containing abundance of nitrogen, in which ammonia is liberated, is generally called *putrefaction*, or the *putrefactive fermentation*. This process appears to be accompanied or produced by the growth of living organisms differing from those causing the fermentations alluded to in the foregoing paragraphs. These are the extremely minute organisms termed *Vibriones* and *Bacteria*. (See VIBRIO.) These appear in myriads during the decomposition which takes place when a piece of meat, &c., slices of potato, fleshy Fungi, &c., are kept moist and exposed to the air for some days in warm weather; and they continue to multiply until the putrefaction is complete, when they die away. It is a question perhaps whether these organisms liberate the ammonia and carbonic acid by a kind of respiration while living, or as an excrement, or whether these gases result from the decay of the dead individuals. These points require much further investigation.

One point of interest connected with the fermentation-plants must not be passed over, viz. that the supposed distinction between the chemical processes of nutrition in animals and plants, falls to the ground when these Fungi are taken into consideration, as they do not live by converting *inorganic* substances into organic compounds, but, like animals, decompose ready-formed organic compounds into others and into their inorganic elements.

BIBL. Turpin, *Mém. du Muséum*, 1840; Berkeley, *Morton's Cyclop. of Agric.* art. Yeast; *Crypt. Botany*, p. 299; Lowe, *Trans. Bot. Soc. Edinb.* 1857; T. Bail, *Flora*, 1857, p. 417; Mulder, *Chem. of Veg. and An. Phys.* Fromberg's transl. 1849, p. 42; Liebig, *Lett. Chemistry* (by Gregory), 1231; Gmelin, *Handb. of Organ. Chem.*; Löwig, *Chem. d. Org. Verb.* i. p. 223; Mitscherlich, *Pogg. Annal.* lv. p. 224; *Lehrb.* 4 ed. p. 371; Cagniard Latour, *Pogg. Ann.* xli. p. 193; Schwann, *ibid.* p. 184; Ure, *Biblioth. Univers. Genèv.* 1839; Helmholtz, *Müller's Archiv*, 1843, p. 453; Boutron and Fremy, *Erdm. and Marchand Jn.* xxiv. p. 364; Pasteur, *Compt. Rend.* 1863 (*Ann. N. Hist.* xi. p. 313). See also TORULA and PENICILLIUM.

FERNS.—This class of Flowerless Plants offers very many points of interest to the microscopist; and indeed the use of magnifying instruments is indispensable in their examination for botanical purposes. The Ferns are characterized by the position of their spore-cases or fruits (sporangia), which are collected into what to the naked eye look like streaks, spots, or patches of a brown colour (*sori*) at the back or lower surface of the leaves or fronds (fig. 221), or at their

Fig. 221.



Scolopendrium vulgare.
Nat. size.

margins,—these *fertile* leaves either resembling the rest, or being modified in a

manner which more or less disguises their nature, as in what are miscalled 'flowering Ferns' (*Osmunda* (figs. 222 & 223), *Botrychium*, &c.).

Fig. 222. Fig. 223.

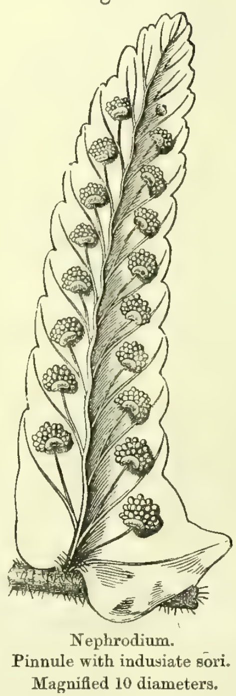
Osmunda regalis.

Fig. 222. Upper part of a frond 1-6th nat. size.
Fig. 223. A fertile pinnule bearing thecæ without parenchyma. Magnified 10 diams.

The Ferns possess a stem which is more or less developed in different cases: in our native kinds it is either a slender, horizontal, subterraneous rhizome or rootstock, or a thick, short, erect one rising little above the ground; but in foreign kinds this erect stem attains the form and dimensions of a tree, growing up into a tall unbranched columnar stem, sometimes more than fifty feet high. The anatomical structure of the stem of the Ferns is peculiar and special, depending on the character and arrangement of the fibro-vascular bundles (see TISSUES, VEGETABLE), which afford the best examples of that form of elementary tissue called the SCALARIFORM DUCTS. The creeping rhizomes are often clothed more or less thickly (as are also the leaf-stalks) with brown membranous scales called RAMENTA; and these often afford elegant microscopic objects, from the peculiar arrangements of the cells. The leaves are generally very greatly developed; and the green blade is of more or less complex structure in different genera. In the *Hymenophylla*, or Filmy Ferns, the leaf is ordinarily a mere membrane of a single layer of cells, through which ramify scalariform ducts, to form the veins—consequently there are no stomata there; but in the other orders, in *Pteris*, for example, the leaf has an upper and lower epidermis with stomata, with loose cellular tissue (*mesophyllum*), between and through which ramify the fibro-vascular veins: the epidermal cells often have elegantly zigzagged or waving side-walls, which produce a pleasing appearance in the sections of the structure obtained in slices shaved off horizontally from the surface of the leaf.

The mode of ramification of the veins or nerves of the leaves is important in systematic Filicology, and may be observed for such purposes by immersing the dried leaflets in turpentine or oil, or mounting them in Canada balsam. The collections of sporangia or capsules on the back of the leaves sometimes occur on all of these; in other cases there are *barren* leaves and *fertile* leaves, the latter of which are generally somewhat modified in form, deprived of a certain portion of the green expanded structure, and reduced occasionally to a mere ramification of veins or ribs supporting the sporangia (fig. 223).

Fig. 224.



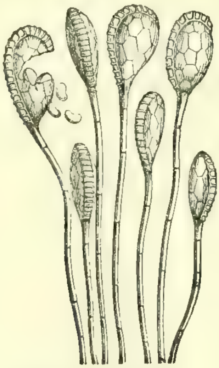
Nephrodium.
Pinnule with indusiate sori.
Magnified 10 diameters.

The groups of sporangia are called *sori*; they differ much in form and arrangement,

and are either naked (*Polypodium*), or covered by a special membranous structure, more or less continuous with the epidermis of the lower surface of the leaf, called an *indusium* (fig. 224); sometimes this indusium is so constructed as to form a kind of cup (figs. 127 & 151), which, again, exhibits a great variety of modifications. (See SORI and INDUSIUM.)

The *sporangia* or *thecæ* are usually collected in great numbers in the sori, and consist of minute stalked sacs or cases, composed of simple cellular membrane, the cells of which are either all alike (OPHIOGLOSSUM), or a row of them running almost round the sac are modified by the thickening of their walls, so as to form an elastic band (*annulus* or *connecticule*), which causes the bursting of the sac when ripe. In the Polypodiaceæ the annulus starts from the stalk of the capsule (fig. 225); in *Hymenophyllum* and *Trichomanes* it runs round in an oblique line (like the ecliptic line on a globe); in *Gleichenia* it is also oblique (fig. 231); and in *Schizæa* and *Aneimia* (fig. 12, p. 39), &c. it forms a kind of cap on the summit of the case.

Fig. 225.



Marginaria verrucosa.
Thecæ. Magnified 25 diameters.

Fig. 226.

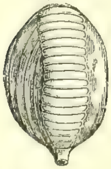


Fig. 227.

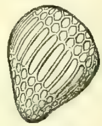
Fig. 228.

Fig. 229.

Fig. 230.

Ceratopteris thalictroides.
Fig. 226. Theca. Magn. 50 diams.
Fig. 227. Do., bursting. Do.
Figs. 228–230. Spores. Magn. 150 diams.

Fig. 231.



Gleichenia.
A theca. Magnified 40 diams.

These membranous sporangia are filled with spores having a double coat, like pollen-grains; and, as in these, the outer coat is ordinarily coloured, and either smoothish or marked with points, streaks, ridges, or reticulations (figs. 228–230, 232–235). (See SPORES.)

Fig. 232.

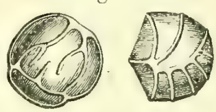


Fig. 233.

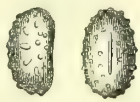


Fig. 234.

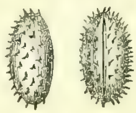
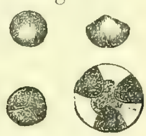


Fig. 235.



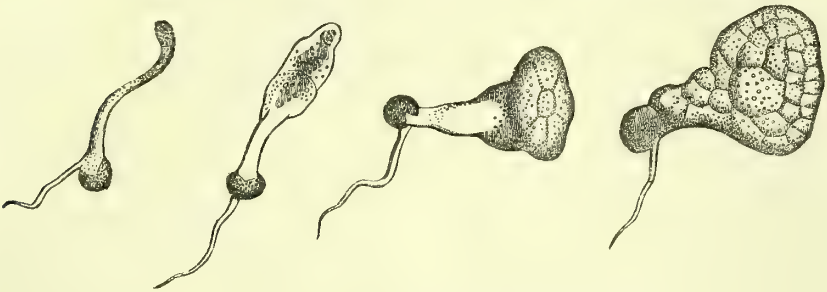
Spores of Ferns.
Fig. 232. Aneimia asplenifolia.
Fig. 233. Polypodium aureum.
Fig. 234. Cystopteris fragilis.
Fig. 235. Pteris longifolia.
Magnified 100 diameters.

The reproduction of the Ferns by their spores exhibits some very remarkable phenomena. When the spores are sown, they germinate after a time by a protrusion of the inner coat as a delicate membranous pouch (fig. 236), which elongates and becomes divided by septa into an articulated cellular filament; some of the cells emit slender tubular filaments (which are not cut off by septa), apparently radical hairs; and while these remain uncoloured, the larger cells from which they arise acquire chlorophyll-granules. The young *prothallium*, as it is called, increases in size by cell-division, and at length acquires somewhat the

form of a heart (figs. 236–239). Some of its cells produce, upon the under surface, the structures called *antheridia*, which consist of stalked cellular bodies, of simple but peculiar structure, in the interior of which are developed minute cellules containing ciliated spiral filaments (*spermatozoids*); these, on the bursting of the antheridial sac, escape not only from this, but from their own parent-cells, and swim about actively in the water by the aid of their vibratile cilia (Pl. 32. fig. 34).

The antheridia are often formed in large numbers, and the prothallium goes on producing them as long as it exists; but at a period somewhat later than that of the earlier antheridia, there appear near the middle, at the front of the under surface of the prothallium, other cellular bodies, of more complex structure, which are the *archegonia* or ovule-like bodies. The archegonium consists of a cellular papilla, composed of a few colourless cells, with a canal running down its centre (an intercellular

Fig. 236. Fig. 237. Fig. 238. Fig. 239.



Germination of Pteris longifolia. Magn. 100 diams.

passage) leading to a cell (*embryo-cell*) at the bottom, contained in a cavity (*embryo-sac*) in the substance of the prothallium. It is supposed that the ciliated spiral filaments make their way down this canal, like the pollen-tubes through the micropyles of Phanerogamous ovules (Hofmeister states that he has actually seen this), and then the embryo-cell becomes developed into an embryo, which soon exhibits rudimentary leaves and rootlets, bursts out from the cavity of the prothallium, which decays away, and grows up into the ordinary leaf-bearing stem of the Ferns (fig. 240). The prothallia bear a variable number of archegonia, but not nearly so many as of antheridia; and they exhibit, in most fully-developed specimens, a number of effete organs of both kinds, which are readily distinguished by the deep-brown colour assumed by the membranes bounding their cavities.

Fig. 240.

Pteris, seedling.

The characters of the prothallium of the *Ophioglosseæ* differ somewhat from the ordinary forms: the prothallium is developed in the soil, several inches below the surface, and is of a whitish-yellow colour internally, being destitute of chlorophyll and starch; its external surface is brown. The antheridia are chiefly produced upon the upper side, the archegonia below, both immersed in the substance of the prothallium. The spermatozoids are described as being larger than in Polypodiaceæ.

The Ferns likewise produce *gemmæ* on the leaves of full-grown plants; and even the prothallia are capable of vegetative multiplication; for if their archegonia are all abortive, they go on vegetating for a long time, and produce new prothallia, by some of their marginal cells budding out and repeating the original mode of growth of the spore itself. These *innovations* usually bear antheridia alone, and not archegonia.

The Ferns are divided into four orders by microscopic characters.

1. Polypodiaceæ. The sporangia on the lower surface of the leaves, in groups of very varied form, but never blended together. The annulus always exists, is variable, and serves to distinguish the tribes.

2. Marattiaceæ. Sporangia on the lower surface of the leaves; usually blended together, sometimes only very closely approximated; without an annulus.

3. Ophioglosseæ. Sporangia on the lower surface of the leaf (reduced to mere

ribs); never blended together; without an annulus.

4. HYMENOPHYLLEÆ. Sporangia attached to a common stalk prolonged from the end of a vein of the leaf, and contained in a kind of cup formed by a lobe of the leaf above and an indusial lobe of similar character prolonged from the lower surface of the leaf. Sporangia with an obliquely transverse annulus.

BIBL. Berkeley, *Crypt. Bot.* p.507; Hooker, *Gen. Filicum*; *Species Filicum*; Presl, *Tent. Pteridographiæ*, Prag, 1836; Payen, *Bot. Cryptogam.* 1850; Bischoff, *Kryptogam. Gewächse*, Nuremb. 1828; Mohl (Structure), in *Martius's Plant. Cryptog. Brasil.*; Moore, *Index Filicum*; *Handb. of Brit. Ferns*; Newman, *Brit. Ferns*. For minute particulars of the reproduction, see Henfrey, *Development of Ferns from their Spores*, *Linn. Trans.* xxi. p. 117, 1853; *Reproduct. of Cryptogamia*, *Ann. Nat. Hist.* 1852; and the papers of Suminski, Hofmeister, Mettenius, De Mercklin, Thuret, and others there quoted; Hofmeister, *Develop. &c. transl. by* Currey, *Qu. Mic. Jn.* 1863, p. 67; King, *Ann. N. H.* 1870, v. 233; Strasburger, *ibid.* 1870, v. 331.

FIBRINE.—Fibrine is soluble in, or rendered so transparent by acetic acid, as to be invisible. Its chemical relation to the other proteine-compounds has not been satisfactorily determined. A substance resembling fibrine in many of its characters, if not identical with it, occurs upon the surfaces of inflamed membranes, &c.; in these cases it generally includes the other elements of inflammation, and almost always a number of minute granules of fat.

Fibrine is coloured by the test-liquids of Millon and Pettenkofer.

The fibrinous plasma of the lower animals resembles fibrine in many respects, but does not separate in fibres.

According to Schmidt's experiments, fibrine does not pre-exist in blood, but is formed by the chemical combination of a fibrogenous substance occurring in the blood-plasma with a fibrino-plastic matter contained in the blood-corpuscles which escapes from them.

BIBL. That of CHEMISTRY, ANIMAL; and Frey, *Histol.*

FIBROINE.—The principal chemical constituent of silk, cobwebs, and the horny skeleton of sponges. In the pure state, it is white, insoluble in water, alcohol, ether, acetic acid, and ammonia.

BIBL. That of CHEMISTRY, ANIMAL.

FIBRO-PLASTIC TISSUE. See TISSUE, FIBRO-PLASTIC.

FIBROUS and FIBRO-VASCULAR BUNDLES. See TISSUES, VEGETABLE.

FIBROUS STRUCTURES OF PLANTS.—This term is somewhat equivocal, and requires a little explanation here. In common language all vegetable substances are termed fibrous which can be separated into more or less fine threads possessing a certain degree of tenacity; special examples are furnished by those forming the materials for textile fabrics. But the anatomical or microscopical structures comprehended here are exceedingly varied, including not only liber-fibres, but spiral vessels, and even hairs. Thus —while Flax (Pl. 21. fig. 2) is the liber of *Linum usitatissimum*, Hemp (Pl. 21. fig. 6) of *Cannabis*, Jute (Pl. 21. fig. 3) of *Corchorus capsularis* &c., Puya (Pl. 21. fig. 26) of *Bœhmeria Puya*, and the material of Chinese grass cloth (Pl. 21. fig. 25) of *Bœhmeria nivea*, Coir (Pl. 21. fig. 4) the liber-like fibre of the husk of the cocoa-nut,—the Manilla hemp (Pl. 21. fig. 7) is composed of the fibro-vascular bundles of *Musa textilis*, and Cotton (Pl. 21. fig. 1) consists of the hairs covering the seeds of species of *Gossypium*. These and similar substances are also spoken of under LIBER, HAIRS, and under their respective heads.

In botanical language, the word fibre has come into use in two very different senses. First, any long cell attenuated to a point at both ends, and with its walls thickened with ligneous secondary deposits, is called a *fibre* by some authors. Thus the term *woody fibre* is applied to the shorter cells of this kind which make up the substance of most solid woods, while the term *liber-fibre* is applied (with more justice) to the often extremely elongated wood-tubes which form the elements of the liber of Dicotyledons and the woody part of the fibro-vascular bundles of the Monocotyledons. (See TISSUES, VEGETABLE.) The characters of structures of this kind will be given under LIBER and WOOD. Secondly, the term *fibre* is applied to the secondary deposits upon the walls of cells, vessels, ducts, &c., which, instead of forming continuous pitted layers, take the pattern of spiral or analogous lines, and, by increasing in consistence, subsequently form real fibres, often elastic and unrollable, of firmer substance than the cell-wall upon which they were originally deposited. The numerous modifications of

these *fibrous deposits* upon the walls of cells are spoken of under the heads of SPIRAL STRUCTURES, VESSELS, and SECONDARY DEPOSITS.

It must not be omitted here that the walls of many cells and liber-fibres, which appear at first sight to be composed of homogeneous laminæ, may often be made to exhibit spiral streaks, by the use of reagents and maceration; indeed they present themselves during the natural dissolution of the membranes of some of the Oscillatoriaceæ (AINACTIS, SCHIZOSIPHON—Pl. 4. figs. 13, 15). Hence some authors have recently recurred to the old notion that all vegetable membranes are formed of fibres cemented or blended together. This is again strongly combated by others, as regards the *primary membrane* of cells. We enter more particularly into the details under the article SPIRAL STRUCTURES of Plants.

FI'CUS, Linn.—(Figs). A large genus of Urticaceæ (Dicotyledons), some of which possess a remarkably thick epidermis and curious pseudo-glandular structures connected with it. *Ficus elastica*, one of the plants yielding india-rubber, now commonly grown in pots in rooms, is a good example. The clavate bodies (Pl. 39. fig. 27) of Meyen, developed in cavities in the leaf, beneath the epidermis, contain crystalline deposits. (See GLANDS and RAPHIDES.)

FILAMENTOUS STRUCTURES OF PLANTS.—This name would be more applicable than *fibrous structures* to such substances as COTTON, which consists of elongated hairs (Pl. 21. fig. 1), and indeed to all elongated cellular filaments with thin and collapsing walls. It would include all long vegetable hairs, like those forming the coma on many seeds (Poplars, *Asclepias*, *Gossypium*, &c.), also those forming felty coatings on the epidermis, as in many Compositæ, &c. It is also applicable to the cells of most of the Confervoid Algæ, to the mycelium (flocci) of Fungi, and to the medullary layer of the Lichens. Many other instances will suggest themselves to the microscopist.

FILA'RIA, Müll.—A genus of Entozoa, of the order Cœlelmintha, and family Nematoidea.

Char. Body filiform, very long, nearly uniform; head not distinct from the body; mouth round or triangular, naked or with papillæ; white, yellowish, or red, from 48 to 100 times as long as broad; œsophagus short, tubular, narrower than the intestine; anus terminal, or nearly so; spicula two, of unequal size, more or less twisted; vulva situated very near the anterior extremity.

Several species, many of which have been but imperfectly examined. They are most commonly found in the abdominal cavity and between the peritoneal folds of mammalia and birds, in the air-cells of the latter, sometimes in the subcutaneous cellular tissue. Species are also met with in reptiles, fishes, and insects.

F. medinensis. The hair- or Guinea-worm. Common in the intertropical regions of the old world. Length 6 to 10″; breadth 1-20 to 1-10″; *F. bronchialis* occurs in the human bronchi; *F. lachrymalis* in the lachrymal gland; *F. oculi* in the globe of the eye, or beneath the conjunctiva; &c.

Two species occur in fresh water, under the leaves of aquatic plants:

1. *F. aquatilis.* Fem. white, constricted behind the spherical head; tegument not striated; œsophagus capillary, very long, sinuous; tail gradually narrowed to a curved point; vulva anterior to the middle of the body; length 3-10 to 4-10″; breadth 1-250″.

2. *F. lacustris.* Fem. reddish-white, slightly narrowed in front, but without a constriction; mouth very small, lateral, and oblique; œsophagus filiform, very long, nodose at its origin; tail conical, obtuse, terminating obliquely in a very small point; tegument not striated; vulva behind the middle; length 1-2″; breadth 1-140″.

BIBL. Dujardin, *Helminth.* p. 42; V. d. Hoeven, *Handb. d. Zool.* p. 179; Diesing, *Syst. Helminth.* ii. p. 263; Kückenmeister, *Parasiten*, p. 304.

FILELLUM, Hincks.—A genus of marine Hydroid Polypi, fam. Lafoëidæ.

1 species: *F. serpens*; common on the larger Sertulariidæ, especially *S. abietina.*

BIBL. Hincks, *Brit. Zooph.* p. 214.

FILICA'CEÆ. See FERNS.

FIR. See PINUS, CONIFERÆ, and WOOD.

FISSIDEN'TEÆ.—A family of operculate Acrocarpous (sometimes cladocarpous) Mosses, of gregarious or cæspitose habit, with simple or much-branched stems. The leaves are amplexicaul (fig. 242), composed of minute parenchymatous cells, closely areolated, often very papillose, produced at the back and point into a lamina beyond the leaf (figs. 243–246), whence *three* parts are distinguished in the latter:—1, the

true horizontal blade; 2, the dorsal lamina, arising vertically from the back of the nerve;

Fig. 241. Fig. 242. Fig. 243.



Fissidens bryoides.

Fig. 241. A plant of F. bryoides. Magn. 5 diams.
Figs. 242 & 243. Leaves detached. More magnified to show the appendage.

3, the apical lamina, the preceding lamina produced beyond the true horizontal blade

Fig. 244.

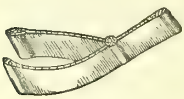


Fig. 245.

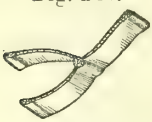
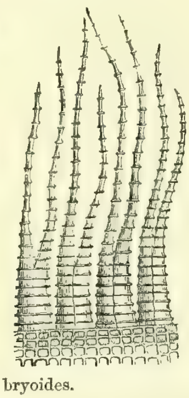


Fig. 246.

Fig. 247.



Fissidens bryoides.

Figs. 244, 245, 246. Sections of 243, at various heights from the base.
Fig. 247. Fragment of peristome. Magn. 100 diams.

of the leaf in a two-edged form, on each side of the nerve. Capsule equal, rarely annulate. British genus: Fissidens.

FIS'SIDENS, Hedw.—A genus of Fissidenteæ. Character that of the family. Inflorescence monœcious or diœcious, terminal on the main stem or on short secondary branches. Montagne has separated the species with an entire calyptra under the generic name of *Conomitrium.*

F. bryoides (fig. 241), not uncommon, is a most elegant little moss.

Bibl. Wilson, *Bryol. Brit.* p. 301.

FISSURI'NA, Reuss.—A compressed *Lagena,* with slit-like aperture. It has the same relation to *Lagena* that *Lingulina* has to *Nodosaria.*

Bibl. Reuss, *Monogr. Lagen.* in *Sitz. Ak. Wiss. Wien,* xlvi. i. 1863.

FISTULI'NA.—A genus of Polyporei (Hymenomycetous Fungi), characterized by the papillæ of the fleshy hymenophorum, being at length elongated, and forming distinct tubes.

Fistulina hepatica occurs not unfrequently on old oaks, on which it sometimes attains an enormous size, and when well dressed is excellent for culinary purposes. The flesh when cut resembles that of beet-root.

Bibl. Huss. i. t. 65; Berk. *Outl.* p. 257, tab. 17. fig. 1; Cooke, *Handb.* p. 292.

FLABELLI'NA, D'Orb.—One of the *Nodosarinæ.* It is dimorphous—that is, having two successive plans of growth:—the first spiral, like that of *Cristellaria*; the later rectilinear, like that of *Nodosaria,* or rather of *Frondicularia,* which latter it resembles in its chevron-shaped flattened chambers. It differs from *Frondicularia* in an eccentricity, or tendency to coil, in the earliest chambers, and thus connects the Stichostegian with the Helicostegian groups. It is to *Frondicularia* as *Vaginulina, Marginulina,* and *Planularia* are to *Nodosaria.* To many large flat *Cristellariæ* (*C. cassis*) semigeniculate chambers give a Flabelline feature; but pure *Flabellinæ* are rare in the recent state (Batsch figured one) and in Tertiary strata. In the Chalk (*Fl. rugosa,* Pl. 18. fig. 38), Gault, Lias, and other Secondary strata, *Flabellinæ* abound.

Bibl. D'Orbigny, *For. Foss. Vien.* 92; Morris, *Brit. Foss.* 35; Parker and Jones, *Ann. N. H.* 3. xii. 136; Carpenter, *Introd. For.* 160, 164.

FLAGELLA'TA. See Infusoria.

FLANNEL, NATURAL.—This term has been applied to sheets or layers of a harsh, fibrous texture, sometimes found covering meadows, rocks, &c. after an inundation. It consists of the interwoven filaments of Confervæ, with adherent or entangled Diatomaceæ, Infusoria, crystals of carbonate of lime, &c. To the naked eye it closely resembles a piece of coarse or loosely woven cloth. Similar layers are

frequently found upon the margins of pools during the summer. As the water evaporates, the Confervæ and other organisms remain supported upon the stems of rushes, or blades of grass, and, when dry, form the yellowish, greenish, or greyish layers of the so-called natural flannel.

See PAPER, METEORIC.

FLAX.—The liber-fibres from the stems of the Flax-plant, *Linum usitatissimum* (nat. ord. Linaceæ, Dicotyledons). Under the microscope, the fibres (Pl. 21. fig. 2) are readily distinguished from those of Cotton by the form and consistence,—being round and attenuated to a point at each end, and of a firm woody consistence, which prevents them from collapsing, and having pits in the wall. New-Zealand Flax is a totally different substance (PHORMIUM). See FIBROUS STRUCTURES of Plants, and LIBER.

FLEA. See PULEX.

FLINT.—The organisms contained in flint are often the same as those met with in moss-agate and Chalk; and the remarks made upon their relation to the formation of that kind of agate apply equally to the case of flint. They consist principally of the fibres, spicula, and gemmules of Sponges, the valves of the Diatomaceæ, fragments of the shells of Mollusca and Echinodermata, the scales of Fishes, and the sporangia of the Desmidiaceæ, which were formerly regarded as distinct organisms (XANTHIDIA).

Flint is not confined to the Chalk, but is found in nearly every limestone, and has arisen from the replacement of the amorphous calcareous matter by silex (as a pseudomorph), generally where decomposing organic matter induced the conditions of change. The crystallized calcite of Echinoderms and some shells is not replaced by silex in limestones, but remains as cavities in exposed flint-masses. Many varieties of limestone, viz. polyzoan limestone in France, freshwater limestone in France and Turkey, orbitoidal limestone in Jamaica, oolitic limestone at Portland and elsewhere, are converted into flint, hornstone, &c. of fine or coarse grain according to the constitution of the original limestone.

In the examination of flint, thin sections should be made by grinding and polishing; some kinds exhibit the organisms contained in them best by reflected, others by transmitted light. Some specimens, in which they are abundant, will exhibit them well in chips removed by a hammer.

See AGATE and CHALK.

BIBL. That of AGATE and CHALK; Ehrenb. *Ann. Nat. Hist.* 1838, ii. 162; Turner, *Phil. Mag.* 1833; Ansted, *Ann. Nat. Hist.* 1844, xiii. 248; Bowerbank, *ibid.* 1847, xix. 240; Charlesworth, *Geol. Jn.* 1847, i. 29; Church, *Proc. Chem. Soc.* 1862; id. *Chem. News*, v. p. 95, and *Phil. Mag.* (4) xxiii. 95; Sutherland, *Geol. Mag.* ii. 220; Johnson, "*Flint*," 1871.

FLORID'EÆ or RHODOSPO'REÆ.—An order of Algæ. Red sea-weeds, some of the common species of which must be familiar to every one, as the delicate feathery or leaf-like plants brought away by most visitors to the sea-coast; and the red colour, more or less permanent or fleeting, is a pretty general characteristic of this order —varying however to purple, brown, and mixed tints of red, green, and yellow, and dirty white. They chiefly grow in deeper water than the other sea-weeds, and are met with in finest and darkest colour in deep tide-pools of sea-water, especially on the side facing the north, where they are overhung by the larger dark-coloured Algæ, and thus shaded from the sun's rays. The greater number do not grow more than six inches high, few more than two feet. The simplest forms are filaments composed of cylindrical cells attached end to end; they next rise to a gelatinous or cartilaginous expansion, composed of such filamentous structures adherent in layers, and forming a compact frond of definite shape. These are said to be of *filamentous structure*. Others have the frond composed of a number of polygonal cells, evenly arranged, and with thick walls, or, as some state, an intercellular substance binding them altogether into a mass; these are technically said to be of *cellular structure*. Sometimes all the cells of the frond contain colouring-matter, sometimes only those of the surface, or of a shallow superficial stratum.

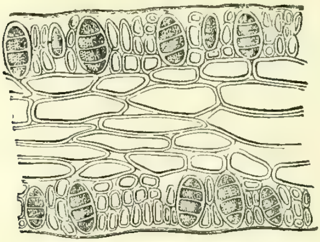
The general external appearance of the Red Sea-weeds is very varied. Sometimes the fronds are like little leafless bushes; at others they form broad laminæ; sometimes the lower part is stalk-like, and the upper parts spread into leaf-like lobes. In *Delesseria* we have a close imitation of a regularly formed leaf of one of the higher plants. The leaf-like forms are either simple, lobed, or exquisitely pinnate or feathered; and the Rhodosperms of warmer climates exhibit most elegantly reticulated fronds. Some of these plants deposit carbonate of lime in their tissues in such quantity that they

become quite stony, so that, the vegetable form alone remaining, they are commonly mistaken for true corals (see CORAL). By placing these *corallines* and *nullipores* in vinegar or dilute hydrochloric acid, the lime is removed, and the cellular vegetable organization may be recognized. The tropical forms of the corallines are far more varied and beautiful than our own.

The fructification of these plants, like that of the other Algæ, is as yet but imperfectly known. We find on them three distinct forms of what appear certainly to be reproductive structures; but their relative and special physiological values have still to be ascertained. The three kinds of structure known are called—1, *tetraspores*; 2, *spores*; 3, *spermatozoids* or *antherozoids*.

1. The *tetraspores*. The structures known under this name are of similar organization throughout the order. They consist of

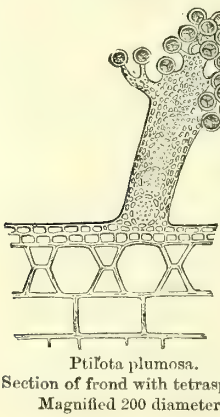
Fig. 248.



Rhynchococcus coronopifolius.
Section of the frond with tetraspores.
Magnified 200 diameters.

an oblong or globular external cell or sac (*perispore*), at first filled with granular con-

Fig. 249.



Ptilota plumosa.
Section of frond with tetraspores.
Magnified 200 diameters.

tents, which contents subsequently separate into four portions, called sporules, either by three transverse fissures (fig. 248); by two fissures at right angles, cutting them into quarters like an orange; or by tri-radiate fissures which part them into the 'tetrahedral' group (fig. 249) so often found in the division of spore- and pollen-cells: the last two occur in the spherical tetraspores. The tetraspores are rarely found collected in any capsular structure; but in the Corallines (fig. 141), and in some few foreign genera, they are grouped in hollow cases (*conceptacles*, fig. 250). In many instances, however, they are found in pod-like bodies (*stichidia*, fig. 157), either formed by metamorphosis of portions of the lobes or lobules of the frond (*Plocamium*), or arising independently on it. In others the tetraspores are naked (*Callithamnion*), scattered over the sides or fixed at the tips of the branches. In the majority of cases, however, these bodies are immersed in the substance of the lobes or lobules, not evident externally except by the darker colour of the frond at the point where they are collected; a lens is then required for their detection; they here appear to be formed either of the cells of the surface or of others immediately subjacent. Harvey, Thwaites, Pringsheim, and others regard these bodies as *gemmules* or *gonidia*; Decaisne, J. Agardh, and other Algologists regard them as true spores. Pringsheim states that in *Ceramium* they grow up at once into a thallus.

Fig. 250.

Hildenbrantia sanguinea.
Section of a conceptacle containing tetraspores.
Magn. 50 diams.

2. The *spores* are simpler structures than the tetraspores, but mostly occupy a more important position. They are never scattered through the frond, but always grouped in definite masses, generally enclosed in a special capsule or *conceptacle* (which by the naked eye may readily be mistaken for a *stichidium* or tetraspore-case). The simplest form of the *spore-fruit* consists of spherical masses of spores attached to the wall of the frond or imbedded in its substance, without a proper conceptacle, in which latter case the cells surrounding the mass of spores are devoid of colouring-matter: such a fruit is called a *favellidium*, and occurs in *Halymenia*; and the same name is ordinarily applied to fruits of similar structure not per-

fectly immersed, such as those of *Gigartina*, *Gelidium*, &c., where they form tubercular swellings on the lobes. In some cases the tubercles present a pore at the summit, when mature, through which the spores find exit. When such a fruit is wholly external, as in *Ceramium* and *Callithamnion*, it is called a *favella*. The *coccidium*, characteristic of *Delesseria*, *Nitophyllum*, &c., which is nearly related to this, either occurs on lateral branches, or is sessile on the face of the frond, and consists of a hollow case with thick cellular walls, containing a dense tuft of angular spores attached to a central column. It is generally imperforate, but occasionally exhibits a pore through which the spores escape. The *ceramidium* is the most complete form of the conceptacular fruit, and is an ovate or urn-shaped case, furnished with an apical pore, and containing a tuft of pear-shaped spores arising from the base of the cavity. The walls are usually thin and membranous, and the hollow space considerable, as in *Polysiphonia*, *Laurencia*, *Dasya*, &c.

From the account given by Pringsheim, of *Ceramium*, it would appear that these (capsule-)spores first produce a kind of prothallium, somewhat in the manner of the higher Cryptogamia.

Peculiar bodies, forming external warts, and composed entirely of vertical fibres, but without spores, called *nemathecia*, are sometimes confounded with the conceptacular fruit, and are probably immature forms of it.

3. The *spermatozoids* are found in peculiar structures, to which the name of *antheridia* has been applied, from the supposed analogy to the organs so called in the other Cryptogamous plants. The *antheridia* are produced pretty much in the same situations as the other organs of fructification, and are always developed on different individuals. They are collections of very small colourless cells, sometimes collected into a bunch, as in *Griffithsia*, sometimes enclosed in a transparent tube, as in *Polysiphonia*, clothing a kind of irregularly-shaped flat plate, as in *Laurencia*, or occupying portions of the general surface of the thallus. Each of the minute cells is said by Nägeli and Derbès to contain a spermatozoid,—according to the former, a spiral filament, which he did not see move,—according to the latter, a transparent globule, with a tail-like appendage moving actively for a few moments. Thuret could not see either the spiral filament or the whip- or tail-like appendage, but believes that the cell of the antheridium contains a transparent corpuscle, spherical in *Polysiphonia*, more or less elongated in other genera, presenting no trace of a spiral thread, but with slightly granular contents. These corpuscles were expelled from the antheridia by a slow movement which appeared purely mechanical; and when outside, they remained at perfect rest.

Synopsis of the Families.

RHODOMELACEÆ. *Frond* cellular, areolated or articulated. *Ceramidia* external. *Tetraspores* in rows, immersed in ramuli, or contained in proper receptacles (*stichidia*).

LAURENCIACEÆ. *Frond* cellular, continuous. *Ceramidia* external. *Tetraspores* scattered, immersed in the branches and ramuli.

CORALLINACEÆ. *Frond* calcareous or crustaceous, rigid. *Ceramidia* external, containing the tetraspores.

DELESSERIACEÆ. *Frond* cellular, continuous, areolated. *Coccidia* external. *Tetraspores* collected into definite clusters (*sori*).

RHODYMENIACEÆ. *Frond* cellular, continuous, the superficial cells minute. *Coccidia* external. *Tetraspores* scattered through the frond, or forming undefined, cloud-like patches.

CRYPTONEMIACEÆ. *Frond* fibroso-cellular, composed of articulated fibres connected together by gelatine. *Favellidia* immersed in the frond or sub-external. *Tetraspores* immersed in the frond.

CERAMIACEÆ. *Frond* filiform, consisting of an articulated filament, simple or coated with a stratum of small cells. *Favellæ* naked berry-like masses. *Tetraspores* external, or partially immersed.

PORPHYRACEÆ. *Frond* plane and exceedingly thin, or tubular and filiform, of a purplish colour, with oval spores in sori, and tetraspores scattered over the frond.

(See the heads of the families for further information.)

BIBL. Harvey, *Brit. Mar. Algæ*, 2 ed. 1849, *Phyc. Brit.*; Kützing, *Phycol. gen.*; Thuret, *Ann. d. Sc. Nat.* 3 sér. xvi. p. 5, 4 sér. iii. p. 5; Derbès and Solier, *ibid.* 3 sér. xiv. p. 261, 4 sér. v. p. 209; Pringsheim, *Berl. Ber.* 1855; *Ann. d. Sc. Nat.* 4 sér. iii. p. 363; *Bot. Zeitung*, xv. p. 784; Henfrey, *Elem. Bot.* (Masters), 1870; Bornet and Thuret, *Ann. d. Sc. Nat.* 1867, p. 166. See also the families.

FLOSCULA'RIA, Oken, Ehr.—A genus of Rotatoria, of the family Flosculariæa.

Char. Attached; eyes two, red; carapace single; rotatory organ divided into more than four lobes, with elongated cilia radiating from their extremities.

Eyes sometimes absent in the adult animals. Sheath or carapace frequently so transparent as to be scarcely distinguishable. Rotatory organ with five or six lobes; the number, however, appears variable; for Ehrenberg, in regard to the genus, states in one place that the lobes are five or six, in another that they are always six. The so-called proboscis is probably only one of the lobes of the rotatory organs.

F. ornata, E. (Pl. 34. fig. 32). Carapace hyaline; rotatory lobes six (Ehr.), five (Duj.), with long cilia, but no central proboscis; aquatic; length 1-108''.

Lobes of rotatory organ thickened at the ends.

F. proboscidea, E. Carapace hyaline; rotatory organ six-lobed, with short cilia surrounding a central proboscis; aquatic; length, when extended, 1-18''. Teeth (fig. 33).

F. campanulata, Dob. Differs from *F. ornata*, Ehr. in having five lobes, and these flattened; aquatic; length, when extended, 1-50''.

F. cornuta, Dob. Rotatory organ five-lobed, one of the lobes with a narrowed, not ciliated cornu attached, arising from its outside; cilia long; aquatic; length, when extended, 1-40''.

These exquisitely beautiful animals are found adhering to aquatic plants, as *Conferva*, *Ceratophyllum*, *&c.*

Bibl. Ehr. *Infus.* 407; Duj. *Infus.* 609; Dobie, *Ann. Nat. Hist.* 1849, iv. p. 233; Cubitt, *Month. Mic. Jn.* 1869, ii. 133 (Pl.), and 1871, vi. 83 (new spec.).

FLOSCULARIÆ'A.—A family of Rotatoria.

Char. Furnished with a carapace or sheath; rotatory organ single, with a flexuous, lobed or divided margin.

The cilia are often long, and only vibrate occasionally, mostly remaining rigidly extended.

Genera.

Eyes absent			1. *Tubicolaria.*
Eye single			2. *Stephanoceros.*
Eyes two	Rotatory organ	2-lobed, single	3. *Limnias.*
		2-lobed, aggregate	4. *Lacinularia.*
		4-lobed	5. *Melicerta.*
		5- or 6-lobed	6. *Floscularia.*

The eyes in some of the genera (*Stephanoceros* and *Floscularia*) disappear in the adult state; so that they must be looked for in the young, or even in the partly hatched ova, in which they may often be distinctly seen.

Bibl. Ehrenberg, *Infus.* p. 398.

FLUS'TRA, Linn. (Sea-mat).—A genus of Cheilostomatous Polyzoa, of the order Infundibulata, and family Flustradæ.

Char. Polypidom plant-like, foliaceous, flexible; cells in contact, alternate, in several rows, and on both sides of the polypidom; aperture transverse, semicircular or lunate, valvular and subterminal. Marine.

Three British species.

F. foliacea. Cells narrow at the base, rounded at the end, with scattered marginal spines. Common; about 4'' high.

F. chartacea. Cells oblong, slightly broader in the middle; lateral margins with a single minute spine.

About 1'' in height.

F. truncata. Cells linear-oblong, truncate at the end, margins without spines; 4–5'' high.

F. carbasea = *Carbasea papyrea*; *F. avicularis* = *Bugula flabellata*; *F. Murrayana* = *Bugula Murr.*; *F. membranacea*, *coriacea*, and *lineata* = *Membranipora m.*, *c.*, and *l.*

Bibl. Johnston, *Brit. Zooph.* 342; Reid, *Ann. Nat. Hist.* 1845, xvi. 385; Busk, *Brit. Mus. Catal.* p. 47.

FLUS'TRADÆ.—A family of Cheilostomatous Polyzoa, of the order Infundibulata.

Distinguished by the expanded, foliaceous, flexible and erect polypidom, with its numerous contiguous cells. Two genera:

Flustra. Cells on both sides.

Carbasea. Cells on one side only.

Bibl. Busk, *Mar. Polyz.* (*Brit. Mus.*) 46.

FLUSTREL'LA, Gray.—A genus of Ctenostomatous Polyzoa, of the order Infundibulata, and family Alcyonidiadæ (?).

Incrusting, cells radiating or alternate, the circumference with setæ; orifice rectangular.

F. hispida. Common near low-water mark upon *Fucus serratus.* Polypidom brown, fleshy.

Bibl. Johnston, *Brit. Zooph.* 363; Redfern, *Qu. Mic. Jn.* vi. 96.

FLY. See Musca.

FONTINA'LIS, L.—A genus of Mosses. See Neckera.

FORAMINIF'ERA.—An order in the Animal Kingdom, belonging to the Subkingdom Protozoa, and class Rhizopoda.

Char. Gelatinous, structureless, usually microscopic, marine animals, contained within calcareous shells, from orifices or pores in which fine retractile processes are emitted, by which locomotion and prehension are performed.

The shells are sometimes simple, consisting of a single cell or chamber (Unilocular, Monothalamous, or Monostegian), as in *Uniloculina*, *Cornuspira*, some *Trochamminæ*, *Lagena*, *Orbulina*, *Ovulites*, *Spirillina*; but the cells are usually aggregated into a compound shell (Multilocular or Polythalamous). In some they are arranged end to end in a straight row (Stichostegian), as in some *Articulinæ*, some *Lituolæ*, *Nodosaria*, *Frondicularia*. In others, the single row is rolled into a spiral (Helicostegian, Nautiloid, Turbinoid, or Fusuline), as in *Peneroplis*, *Lituola*, *Cristellaria*, *Polystomella*, *Globigerina*, the *Rotalinæ*, *Nummulina*, *Fusulina*. Or the cells are arranged in two alternate rows, spirally coiled (Entomostegian), as in *Valvulina*, *Bulimina*. Sometimes the cells form two or three alternate rows, but not spirally coiled (Enallostegian), as in *Polymorphina*, *Uvigerina*, *Textilaria*; whilst in others the cells are arranged around an (imaginary) axis, upon two or more opposing faces (Agathistegian), as in *Miliola*. There are also discoidal shells with alternately concentric cells (Cyclostegian), as *Orbitolites* and *Cycloclypeus*. Many modifications, with dimorphic and even trimorphic modes of growth, also exist; thus *Textilaria annectens* (Pl. 18. fig. 52) is helicostegian at first, enallostegian subsequently, and stichostegian at last; whilst *Bigenerina* and *Clavulina* (Pl. 18. figs. 50 & 51) have only the alternate and linear modes of growth; and *Spirolina* (Pl. 18. fig. 12) is first spiral and then linear. Between the chambers are septa, consisting of either single or double plates, perforated by one or more apertures (whence the name Foraminifera), the margins of which are sometimes tubular or prolonged to form an imperfect tube, as shown in the same figure. This tube is sometimes turned inwards (entosolenian). As the more recently formed chambers are often larger than the others, the shells are often more or less conical or pyramidal. The lines of junction of the chambers visible externally, are called the septal lines; these are sometimes sunk, sometimes raised into ridges. Frequently the outer chambers extend laterally beyond the inner, so as to conceal them; they are then said to be embracing. In a few of the Foraminifera, the shells are composed of a number of perfectly distinct cells, each with a separate outer orifice (*Dactylopora*, Pl. 18. fig. 53).

The plan of growth offers no solid ground for the classification of these organisms; but the character of their shell-structure serves better; for there are two distinct kinds of shell; one white, opaque, and not traversed with tubules ("porcellaneous" and "imperforate"), such as the *Miliolæ*; the other subtranslucent and tubular ("vitreous" or "hyaline," and "perforate"), such as *Nodosarina*, *Bulimina*, and *Nummulina*. Shells of each kind, however, are liable to become "arenaceous," by particles of sand or minute organisms being taken up in their structure, as *Quinqueloculina*, *Lituola*, *Trochammina*, *Valvulina*, *Textilaria* and *Bulimina*.

The surface of the hyaline shells presents a punctate appearance, arising from the presence of very numerous foramina, which are the outer orifices of tubules passing through the walls of the shell. The arrangement of these tubules and that of another set traversing the walls and the septa, as well as, in fact, the general structure of the shell, may be illustrated by a description of the shell of *Operculina arabica* (Pl. 47. fig. 23), in which they have been carefully traced by Mr. Carter. Here the outer surface, after the removal of a greenish epidermic layer, is seen to be covered with large and small papillæ—the former 1-2150″, the latter 1-8600″ in diameter—neither of which are present over the septa or at the margin of the shell. Each of the septa encloses within its walls two calcareous tubes, spaces, or channels, one on each side—the intraseptal channels (fig. 26); these are about 1-1900″ in diameter, and in their course give off two sets of lateral branches, terminating upon the two surfaces of the septum in which they run. The tubes communicate at each end with a network of smaller ones; one set of which ramifies in the upper, the other in the under wall or margin of each chamber; these are the marginal plexuses (fig. 24 *h*); and the former terminate upon the outer margin of the shell (*g g*). The inner wall of the chambers is pierced by innumerable tubules about 1-9000″ in diameter, which pass directly downwards from the small papillæ on the outer surface. In a vertical section of the shell, in addition to these

minute tubes, seven, eight or more parallel horizontal lines are seen (fig. 25 *c*); these are the lines of contact of the layers composing the shell, or the lines of growth. The margin of the shell is traversed by elongated inosculating vessels, which cause this marginal portion to break up into hollow calcareous spicula (fig. 24), 1-237″ long and 1-900″ broad. In a transverse section of the margin, more than 100 of these are seen, forming a triangular bundle or cord (fig. 25 *a*), the apex being directed towards the chamber, the base outwards forming the free rounded margin of the shell; and parallel to its sides run the papillary tubes of the chamber (fig. 25 *b*).

In addition to the common foramina and the orifices of the marginal plexus, the chambers, especially those which terminate the series, are furnished with other larger orifices opening externally; these are of various forms and differently situated; sometimes they are round, numerous, and comparatively small; at others they are single and large, circular, semicircular, or lunate, &c.

The nature of the Foraminifera has been very differently viewed. They were formerly regarded as microscopic Cephalopoda, then as Bryozoa (Polyzoa), and again as intermediate between the Polypi and Echinodermata. Dujardin's view, however, is now adopted, that their structure is very simple, and that they are closely allied to the Arcellina, the body being single and composed of a simple sarcodic substance, without the distinct separation of organs, and the filiform processes (pseudopodia) which issue from the various external apertures of the shell, being comparable with those of *Amœba*, *Arcella*, and other members of the family. Ehrenberg and Vogt regard the various segments contained in those shells which have septal communications as distinct animal bodies, organically united, as in the Polyzoa; others regard the whole as a single body.

The colour of the body is variable—yellow, red, green, blue, or violet. Ehrenberg observed that the first and largest chamber, sometimes also the second, and occasionally those as far back as the fourth, frequently contain a transparent colourless substance only, whilst beyond this the cells are filled with two differently coloured matters—one greenish, and containing Diatomaceæ, &c., the other being yellowish, and supposed by him to represent the ovarium.

The nature of the contents of the intraseptal and marginal vessels is doubtful; Mr. Carter regards them as performing a water-vessel function comparable to that of the circulating system of the sponges (*Grantia*), whilst Williamson and Carpenter consider them to be filled with the organic substance of the body.

The shells of the Foraminifera are composed principally of carbonate of lime, and therefore effervesce copiously when a dilute acid is added to them. By carefully acting upon the recent organisms with muriatic acid, in the proportion of a drop of the strong acid to a watchglassful of water containing them, the animal is left (Pl. 18. figs. 32, 35), retaining the general form of the shell, which it has moulded upon itself.

In the porcellaneous group the shell-matter covers each segment of sarcode tent-wise, the edges of the new chambers resting on the outside of the older part of the shell. In the "hyaline" group each segment is, in many cases, fully enwrapped with shell, except at the septal orifice, through which the stolon connects the new and old segments. Besides this tubuliferous shell-layer, many of the hyaline Foraminifera lay down other coats before new segments are thrown off; and these supplementary layers form the "intermediate skeleton," in which vessels or canals, for the sarcode passing outwards, are more or less prevalent, constituting the "Canal-system."

Recent Foraminifera can be procured by dredging, or sometimes from the sand of the sea-shore. They often form white lines or bands, between tide-marks. To separate them, the sand should be washed in fresh water, dried, and spread upon a piece of black paper, or the black disk (Introd. p. xxiv), and examined as an opaque object; when the shells, easily distinguished by their forms, may be picked out by means of a mounted bristle.

Or the dried sand may be stirred up with water and allowed to settle; the sandy particles will then subside, and the shells, from their chambers being filled with air, may be skimmed off the surface; or they may be poured off through muslin, with the disturbed water, before all the sediment has had time to settle.

In the fossil state, the Foraminifera abound in chalk, from which they may be obtained in the manner directed under Chalk; in fact this substance constitutes one of the best sources of them for examination. In other calcareous rocks or limestones they are also extremely numerous.

Thus in the stone of which the buildings in Paris are constructed, the shells of the Miliolida are so abundant, that this city may be said to be built of them.

The Nummulites or coin-stones which form mountains in the Mediterranean and North-Indian regions, and of which the pyramids of Egypt are principally composed, are Foraminifera (Pl. 47. figs. 21, 22).

Many clays, such as those of the Lias, the Oolitic and Cretaceous series, the London Tertiaries, those of Prussia, Belgium, Malaga, San Domingo, &c., and many shelly sands of Tertiary age in Suffolk, Italy, Germany, France, New Zealand, Australia, and elsewhere, also yield Foraminifera by careful washing.

See the articles Chalk and Rhizopoda.

Synoptical List of the Genera and Subgenera of Foraminifera.

I. IMPERFORATE or PORCELLANEOUS FORAMINIFERA.

1. Nubecularida.
   Squamulina, Schultze.
   Nubecularia, Defrance.

2. Miliolida.
   Vertebralina, D'Orb. Pl. 18. fig. 10.
   a. *Articulina*, D'Orb. Pl. 18. fig. 9.
   Cornuspira, Schultze (restricted). Pl. 18. fig. 13.
   Miliola, Lamarck. Pl. 18. fig. 1.
   a. *Uniloculina*, D'Orb. Pl. 18. fig. 2.
   b. *Biloculina*, D'Orb. Pl. 18. fig. 3.
   c. *Triloculina*, D'Orb. Pl. 18. fig. 4.
   d. *Quinqueloculina*, D'Orb. Pl. 18. figs. 5, 6.
   e. *Cruciloculina*, D'Orb.
   f. *Spiroloculina*, D'Orb. Pl. 18. fig. 7.
   Hauerina, D'Orb. Pl. 18. fig. 8.
   Fabularia, Defrance.

3. Peneroplida.
   Peneroplis, Montfort. Pl. 18. fig. 11.
   a. *Spirolina*, Lamarck (restricted). Pl. 18. fig. 12.
   b. *Dendritina*, D'Orb.

4. Orbiculinida.
   Orbiculina, Lamarck. Pl. 18. fig. 19.
   Orbitolites, Lamarck. Pl. 18. fig. 17.
   a. *Pavonia*, D'Orb.
   Alveolina, D'Orb. Pl. 18. figs. 15, 16.

5. Dactyloporida.
   Haploporella, Gümbel (*Dactylina*, Zborez?). Pl. 18. fig. 53.
   Dactyloporella, Gümb. (*Dactylopora*, auct. in parte). Pl. 18. fig. 54.
   Thyrsoporella, Gümb.
   Gyroporella, Gümb.
   Cylindrella, Gümb.
   Uteria, Michelin.
   Acicularia, D'Archiac.

II. ARENACEOUS FORAMINIFERA.

1. Parkeriada.
   Parkeria, Carpenter.
   Loftusia, Brady.

2. Lituolida.
   Involutina, Terquem.
   Endothyra, Phillips.
   Trochammina, Parker and Jones. Pl. 18. fig. 14.
   Webbina, D'Orb. (restricted). Pl. 18. fig. 21.
   Valvulina, D'Orb. Pl. 18. fig. 20.
   Tetraxis, Ehrenberg.
   Saccammina, Sars.
   Astrorhiza, Sars.
   Botellina, Carpenter.
   Lituola, Lamarck. Pl. 18. fig. 18.
   Placopsilina, D'Orb.
   Haplophragmium, Reuss.
   Polyphragma, Reuss.

   [*Ataxophragmium*, Reuss (sandy *Bulimina*).
   Plecanium, Reuss (sandy *Textilaria*).]

III. PERFORATE or HYALINE FORAMINIFERA.

1. Lagenida.
   Ellipsoidina, Seguenza.
   Lagena, Walker and Jacob (in Kanmacher). Pl. 18. figs. 22, 24, 25, 26, 27.
   a. *Entosolenia*, Ehrenberg. Pl. 18. fig. 23.
   b. *Fissurina*, Reuss.
   Nodosarina, Parker and Jones.
   a. *Glandulina*, D'Orb. Pl. 18. fig. 28.
   b. *Nodosaria*, Lamarck. Pl. 18. fig. 28.
   c. *Dentalina*, D'Orb. Pl. 18. fig. 33.
   d. *Dentalinopsis*, Reuss.
   e. *Lingulina*, D'Orb.
   f. *Lingulinopsis*, Reuss.
   g. *Rimulina*, D'Orb.
   h. *Vaginulina*, D'Orb. Pl. 18. fig. 35.
   i. *Marginulina*, D'Orb. Pl. 18. figs. 30, 31, 32.
   j. *Cristellaria*, Lamk. Pl. 18. figs. 34, 37.
   k. *Planularia*, Defr.

l. *Flabellina*, D'Orb. Pl. 18. fig. 38.
m. *Frondicularia*, D'Orb. Pl. 18. fig. 39.
n. *Amphimorphina*, Neugeb.
Orthocerina, D'Orb. Pl. 18. fig. 36.

2. Polymorphinida.
Polymorphina, D'Orb. Pl. 18. figs. 40, 41, 42, 43.
a. *Dimorphina*, D'Orb. (restricted).
Uvigerina, D'Orb. Pl. 18. fig. 44.
a. *Sagrina*, D'Orb. (restricted).

3. Buliminida.
Bulimina, D'Orb. Pl. 18. fig. 46.
a. *Bolivina*, D'Orb.
b. *Virgulina*, D'Orb.
c. *Bifarina*, P. & J.
d. *Robertina*, D'Orb.
e. *Ataxophragmium*, Reuss (sandy).
Cassidulina, D'Orb. Pl. 18, fig. 45.
a. *Ehrenbergina*, Reuss.

4. Textilarida.
Textilaria, Defrance. Pl. 18. figs. 47, 52.
a. *Vulvulina*, D'Orb. Pl. 18. fig. 49.
b. *Cuneolina*, D'Orb.
c. *Spiroplecta*, Ehrenb.
d. *Bigenerina*, D'Orb. Pl. 18. fig. 50.
e. *Venilina*, Gümbel.
f. *Clavulina*, D'Orb. (restricted). Pl. 18. fig. 51.
g. *Verneuilina*, D'Orb.
h. *Tritaxia*, Reuss.
i. *Candeina*, D'Orb.
j. *Gaudryina*, D'Orb. Pl. 18. fig. 48.
k. *Heterostomella*, Reuss.
l. *Plecanium*, Reuss (sandy).

5. Globigerinida.
1. *Globigerinina.*
Ovulites, Lamarck.
Orbulina, D'Orb. Pl. 47. fig. 1.
Globigerina, D'Orb. Pl. 47. figs. 2, 3.
Pullenia, Parker and Jones.
Sphæroidina, D'Orb. Pl. 47. fig. 4.
Allomorphina, Reuss.
Chilostomella, Reuss.
Carpenteria, Gray.
2. *Rotalina.*
Spirillina, Ehrenb. (restricted). Pl. 47. fig. 5.
Discorbina, Parker and Jones. Pl. 47. fig. 7.
Planorbulina, D'Orb. Pl. 47. figs. 6, 10, 12.
a. *Planuliua*, D'Orb.
b. *Truncatulina*, D'Orb. Pl. 47. fig. 9.
Pulvinulina, Parker and Jones. Pl. 18 a. figs. 11, 16.
Rotalia, Lamarck (restricted). Pl. 47. figs. 13, 14.
Cymbalopora, Von Hagenow. Pl. 47. fig. 17.
Thalamopora, Reuss.
Calcarina, D'Orb. Pl. 47. fig. 27.
Tinoporus, Montfort.
Patellina, Williamson. Pl. 47. fig. 8.
Polytrema, Risso.
3. *Polystomellina.*
Polystomella, Lamarck. Pl. 18. fig. 55; Pl. 47. figs. 19, 20.
a. *Nonionina*, D'Orb. Pl. 47. fig. 18.
4. *Nummulinina.*
Nummulina, D'Orb. Pl. 47. figs. 21, 22.
a. *Operculina*, D'Orb. Pl. 47. figs. 23, 24, 25, 26.
b. *Assilina*, D'Orb.
Amphistegina, D'Orb. Pl. 47. fig. 28.
Heterostegina, D'Orb.
Cycloclypeus, Carpenter.
Orbitoides, D'Orb.
Fusulina, Fischer. Pl. 47. fig. 15.
Orobias, d'Eichwald.
Eozoon, Dawson.

Bibl. D'Orbigny, *Dict. Sc. Nat.* 1826, vii.; *Mém. Soc. Géol. France*, iv. i.; *Dict. D'Hist. Nat.* 1845, v.; *Foramin. foss. Vien.* 1846; Ehrenb. *Mikrogeologie*, 1854; id. *Abhandl. Akad. Berlin*, 1838, 1839, 1841, 1847, &c.; Weaver, *Ann. N. H.* 1841, vii. 296, 374; Dujardin, *Ann. d. Sc. Nat.* 1835, iv. and v.; Clark, *Ann. Nat. Hist.* 1849, iii. 388, 1850, v. 161; Williamson, *Trans. Micr. Soc.* ii., and *Recent Foraminif.* (*Ray Soc.*); Carpenter, *Trans. Geol. Soc.* 1849; *The Microscope*; *Phil. Trans.* 1856, 59, 60, 69; *Introd. Foram.*; Carter, *Ann. Nat. Hist.* 1852, x., 1253, xi., and 1854, xiv.; Schultze, *Ueber Organism. Polythal.*; *Müller's Archiv*, 1856 (*Q. J. Micr. Soc.* v. 220); *Wiegmann's Archiv*, 1860 (*Ann. N. H.* 3. vii. 306); Parker, Jones, and Brady, *Ann. N. H.* 2. xix.; 3, iii., iv., vi., viii., xi., xii., xv., xvi.; 4, iv., vi., viii., ix., x.; *Q. J. Geol. Soc.* xvi. 292, 452; xxviii. 103; *Phil. Trans.* 1865; *Tr. Linn. Soc.* 1864 and 1870; *Monogr. Crag For.* (*Pal. Soc.*) 1866; Reuss, *Verst. Böhm. Kreid.* 1845–46; *Haiding. Abhandl.* iv.; *Denksch. Akad. Wien*, i., vii., xxiii., xxv.; *Sitz. Ak. Wien*, passim; *Zeitsch. deut. geol. Ges.* iii., vii., &c.; Gümbel, *Abhandl. bayr. Ak.* x. &c.; also the memoirs of Soldani, Römer, Von Hagenow, Philippi, Reuss, Czjzek, Alth, Bornemann, Egger, Neugeboren, Karrer, Stache, Schwager, &c.

FOR'DA, Heyden. See APHIDÆ.

FORFICULA, Linn.

F. auricularis is the common earwig.

FORMIC ACID, or acid of ants.—This acid occurs in ants, especially the red ant, *Formica rufa*; in the stinging hairs of some insects, as of the procession-caterpillar (*Bombyx processionia*); and in the poisonous secretion of the stings of insects; perhaps also in the stinging organs of the Acalephæ and Polypes. In the higher animals it is a frequent product of the oxidation of organic substances, and is also found in the juice of flesh, in the urine, in vomited liquids, and in the blood, also in the stinging hairs of the nettle &c.

See CHEMISTRY.

FOSSIL INFUSORIA. — The fossil valves of the Diatomaceæ were formerly so called. See DIATOMACEÆ.

FOSSIL WOOD.—This occurs in very different conditions:—as, for example, converted into lignite, and the modifications of coal; or with the vegetable substance almost entirely removed and replaced by silex, preserving all the organic forms of the tissues. The mode of examining and mounting COAL, &c., is given under that article. Silicified woods which have been completely infiltrated and solidified require to be cut into thin sections and polished by the lapidary; the friable kinds, where the infiltration has merely filled the cavities of the cells and vessels, may be split with a knife and mounted in balsam. Examples are given in Pl. 19. figs. 29–33. Pl. 39. fig. 32, exhibits concretions of silica imitating structure. The stems of Palms and Dicotyledonous trees are met with completely converted into siliceous blocks, sections of which exhibit all the minutiæ of the structure.

FOSSOMBRO'NIA, Raddi.—A genus of Pellieæ (Hepaticæ), nearly allied in the character of its vegetative structure to the Jungermannieæ, having large, squarish, irregularly waved leaves. The stout stems are procumbent, and set with purple radicles all along the underside. The fruit-stalk arises from the underside of the stem, and turns back; the perichæte is very large; and the capsule bursts irregularly into four slender erose valves. *F. pusilla* is the *Jungermannia pusilla* of the British Flora; found chiefly on clay banks.

BIBL. Hook. *Brit. Jungerm.* pl. 69, *Brit. Flor.* ii. pt. 2. p. 117; Endlicher, *Gen. Plant.* suppl. i. no. 472–7.

FOVIL'LA.—The name applied to the minute granules contained in the liquid filling the pollen-cell and passing into the pollen-tube of Flowering Plants. These minute granules, which are of various but altogether indefinite sizes, exhibit an active quivering motion—the 'molecular motion,' as it is called—which is displayed in the same way by all finely-divided solid substances, living or dead, and is apparently dependent on purely physical causes. They appear to consist of starch-grains, minute globules of oil, and granules of protoplasm probably composed of proteine compounds. These granules are exceedingly transparent in many kinds of pollen when fresh, apparently from their refracting power being nearly equal to that of the fluid surrounding them. The granules may then be made visible by adding water.

FRAGILA'RIA, Lyngb. — A genus of Diatomaceæ (Cohort Fragilarieæ).

Char. Frustules (in front view) linear, symmetrical, united into straight or twisted flat filaments; valves lanceolate, oblong or linear.

Differs from *Diatoma* in the filaments not becoming separated into zigzag chains. Transverse striæ only visible under oblique or "stopped" illumination.

Kützing enumerates sixteen species, of which ten are doubtful. Rabenhorst admits 9 species, with numerous varieties.

F. capucina, K. (*F. rhabdosoma*, E.) (Pl. 12. fig. 33). Frustules linear in front view; valves narrowly and acutely lanceolate; breadth of filament 1-700″. Aquatic. Common in pools, &c.

β. Valves attenuate towards the obtuse ends.

F. virescens, Ralfs (*F. pectinalis*, Ehr.). Frustules in front view linear, rectangular or cuneate; valves obtuse at the contracted and produced ends. Aquatic. Endochrome green.

β. Valves cohering by the angles only.

F. striatula. Valves linear, narrowed towards the very obtuse ends. Marine.

BIBL. Kützing, *Bacill.* p. 45; id. *Sp. Alg* p. 14; Ralfs, *Ann. Nat. Hist.* 1843, xii. 106 Smith, *Brit. Diat.* ii. 21; Rabenhorst, *Flor. Alg.* i. p. 118.

FREDERICEL'LA, Gervais.—A genus of Polyzoa, of the order Hippocrepia, and family Plumatellidæ.

Char. Polypidom fixed, coriaceous, tubular, branched; polypes protruding from the ends of the branches; tentacular disk nearly circular; tentacles about twenty-four, ar-

ranged on the margin of the disk in a single series, and invested at their origin by a membrane. Aquatic.

F. sultana. Polype-cells erect, cylindrical. Height of polypidom about 2″; tufted, shrubby; stem dichotomously branched. Eggs bean-shaped, smooth.

BIBL. Allman, *Freshw. Polyzoa* (*Ray Soc.*), 110; Johnston, *Br. Zooph.* p. 405.

FREI'A, Cl. & L.—A genus of Infusoria, of the family Bursarina.

Char. Those of *Stentor*, with the buccal spire borne by an anterior membranous bilobed expansion.

3 species: marine.

F. elegans (Pl. 48. fig. 1.)

BIBL. Clap. and Lachm. *Infus.* p. 217; St. Wright, *Qu. Mic. Jn.* 1862, p. 217.

FREY'A. See FREIA.

FROG.—The common frog (*Rana temporaria*) affords a means of studying several interesting points of structure. Thus, by gently scraping the back of the roof of the mouth with the handle of a scalpel, ciliated epithelium (Pl. 40. fig. 13) may be obtained, and the ciliary movement studied. The circulation in the web of the foot, and the phenomena of inflammation may be observed, by enclosing a frog in a wet bag, leaving one leg projecting. The bag containing the frog may then be placed upon a plate of wood, with a circular aperture at one end, over which the foot is to be extended by tying the toes with silk or cotton threads to little tacks or nails driven into the wooden plate. Metal "frog-plates" are sold for the purpose. Sections of the kidney of the frog, made with a Valentin's knife, will show the ciliated epithelium of the necks of the urinary tubules. The circulation of the blood in the lungs and the mesentery may be examined; but the animal should be rendered insensible by chloroform before the experiment.

The ova of the frog (frogs' spawn) have formed the subject of some of our most interesting experiments on impregnation and development. The larvæ (tadpoles) exhibit well the circulation in the gills, tail, and more transparent parts, and afford easily obtained materials for the study of the development of the tissues. The chorda dorsalis is well seen in a young tadpole. The frog and tadpole, however, are inferior in most respects to the Triton and its larva for exhibiting these phenomena.

The injected organs of the frog afford most interesting and beautiful preparations, especially the lungs, kidneys, skin, tongue, and web of the foot. The injection should be thrown in at the heart, and the slightest possible force used.

The simplest method of killing a frog without injury, is to immerse and retain it in warm water. The primary effect of this process, however, is only that of producing asphyxia; so that if it be removed from the water and exposed to the air too soon after immersion, even, as in injection, after the pipe has been fixed in the heart, it will revive; and probably when the operator has returned from stirring the injection, the frog will have vanished, and may be found jumping on the floor. Such unnecessary cruelty may easily be avoided by attending to the above remark.

The muscles of the frog often contain a nematoid parasite (*Myoryktes Weissmanni*).

FRONDICULA'RIA, Defr.—This pseudo-genus comprises complanate stichostegian *Nodosarinæ*, which have geniculate or chevron chambers. They are the extremely compressed and dilated forms of the group, having the quasi-genus *Lingulina* to connect them with the cylindrical *Nodosariæ*. In *Frondicularia* the shell is equilateral; narrow-oblong, rhomboidal, or ovate; greatly compressed; chambers in a straight row, depressed, each forming two sides of a triangle, with the angle sometimes prolonged; septal lines often raised as ridges; intermediate spaces sometimes striate; first chamber oval; aperture round, on the upper angle.

Recent in the Atlantic. Fossil in the Tertiaries of Italy, Spain, and West Indies; and abundant in the Chalk, Gault, Lias, and other fossil clays. *Fr. spathulata* (Pl. 18. fig. 39) shows the early portion of a specimen from the Chalk, closely allied to the typical *Fr. complanata*, Defr.

BIBL. D'Orbigny, *For. Foss.* 57; Williamson, *Rec. For.* 23; Morris, *Brit. Foss.* 35; Reuss, *Böhm. Kreid.*; Carpenter, *Introd. For.* 160, 164.

FRONTONIA, Ehr.—A genus of Infusoria, of the family Bursarina (Cl. & L.).

Char. Resembles *Ophryoglena*, except in the absence of the watch-glass organ.

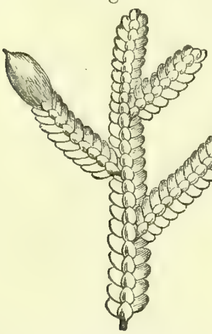
Most of the species of Dujardin's genus *Panophrys* belong here.

F. leucas (*Bursaria l.*, Ehr.). Parenchyma armed with trichocysts; buccal fossa oval, pointed behind; a single contractile vesicle. Aquatic.

BIBL. Ehrenberg, *Infus.* 329; Clap. & Lachm. *Infus.* p. 259.

FRULLA'NIA, Raddi.—A genus of Jungermannieæ (Hepaticæ), containing three British species, the *Jungermannia Hutchinsiæ, dilatata,* and *Tamarisci* of Hooker's British Flora. *F. dilatata* is very common, creeping on the bark of trees, its dark brown dry foliage appearing like minute spreading

Fig 251.



Frullania Tamarisci.
Portion of a stem, with branches bearing the perichætes from which the sporanges emerge.
Magn. 5 diams.

blotches; the almost sessile capsules are somewhat inconspicuous, but are distinguished by their whitish colour. The valves of the capsule and the elaters afford beautiful microscopic objects, illustrative of the spiral structures in cells. *F. Tamarisci* (fig. 251) has longer and more regularly pinnate stems, forming large lax tufts on the ground and low bushes, chiefly in Subalpine countries.

BIBL. Hook. *Brit. Jungerman.* pls. 1, 5, 6; *Brit. Flora,* ii. pt. 1. p. 128; Endlicher, *Gen. Plant.* Suppl. i. No. 472–10.

FRUSTU'LIA, Ag.—A genus of Diatomaceæ.

Char. Frustules naviculoid, free or irregularly scattered through an amorphous gelatinous mass; valves elliptic-lanceolate, without central and terminal nodules; longitudinal line interrupted in the middle. Aquatic.

F. salina, Ehr. Frustules in front view very narrowly linear, rounded at the ends; valves suddenly acute at the ends; transverse striæ evident; gelatinous envelope continuous; length of frustules 1-2200 to 1-864''. Found in a saline spring.

This organism is of particular interest, as having formed the subject of Schmidt's ultimate analysis, in which he determined the presence of cellulose. (DIATOMACEÆ, p. 238.)

F. saxonica, Rab. (Pl. 14. fig. 17). Frustules in front view linear, rounded at the ends; valves elliptical, somewhat acute.

Forms dirty olive-brown, gelatinous, tremulous masses, contained in small pits in rocks.

F. membranacea, nobis (Pl. 41. fig. 6). Frustules in front view linear, very slightly narrowed towards the ends; valves lanceolate, constricted near the obtuse ends; length of frustules 1-1250''.

Found abundantly forming a thin stratum or film upon the sides of a glass jar containing water-plants.

Rabenhorst describes 5 species.

BIBL. Ehrenb. *Infus.* p. 232; Kützing, *Bacill.* p. 109; id. *Sp. Alg.* p. 96; Rabenhorst, *Flora Alg.* i. p. 227.

FUCA'CEÆ—A family of Fucoideæ. Olive-coloured inarticulate sea-weeds, whose reproductive organs are borne in stalked sacs upon the walls of spherical cavities excavated in the substance of the frond. *Fructification, sporanges* or spore-sacs and *antheridia.* The spores of *Fucus* divide into two, four, or eight within the sac; those of the other genera remain undivided. The antheridia are filled with spermatozoids (or antherozoids), which in *Fucus* have been seen to fertilize the spores. See FUCUS.

British Genera.

* *Air-vessels stalked.*

Sargassum. Branches bearing ribbed leaves; air-vessels simple.

Halidrys. Frond linear, pinnate, leafless; air-vessels divided into several cells by transverse partitions.

** *Air-vessels immersed in the substance of the frond or absent.*

Cystoseira. Root scutate. *Frond* much branched, bushy. *Receptacles* cellular.

Pycnophycus. Root branching. *Frond* cylindrical. *Receptacles* cellular.

Fucus. Root scutate. *Frond* dichotomous. *Receptacles* filled with mucus, traversed by jointed threads.

Himanthalia. Root scutate. *Frond* cup-shaped. *Receptacles* (frond-like) very long, strap-shaped, dichotomously branched.

FUCOI'DEÆ, or MELANOSPOREÆ.—An order of Algæ, deriving their ordinary name from the *Fucus* or *Wrack,* one of the most frequent genera of the family. They

present many remarkable points of difference from the red sea-weeds in their higher forms, while the lowest forms approach the simpler genera of that order and the higher forms of the Chlorosperms. The Fucoids are exclusively marine, and are at once distinguished by their olive or dark-brown colour; and although some of the larger kinds grow in deep water, the majority are met with on rocks between high- and low-water mark, where they are exposed to the atmosphere at each efflux of the sea: those which are occasionally drawn up from deep water prove that this exposure is necessary for healthy growth, by their weak structure and the absence of fructification. Some of them are also provided with air-bladders, which maintain them floating or erect and with at least their upper lobes little beneath the surface of the water. These air-bladders are very well seen in our common Bladder-wrack (*Fucus vesiculosus*, fig. 252), and still more so in the celebrated Gulf-weed (*Sargassum bacciferum*), where the stalked berry-like bladders are the most striking feature of the plant.

All the larger kinds grow on rocks, to which they are attached by a root-like structure, of somewhat conical form, cleaving, like the 'sucker' with which school-boys lift stones, to the rock; in many this cone is solid, and composed of tough cellular tissue; in others, especially the Laminariaceæ, it is composed of a number of stout, superjacent, branched cords, growing out of the frond one above another, and attaching themselves to the rock, like the roots of a Tree fern or a Palm. Some (*Pycnophycus*) spring from a creeping stem-like portion, spreading in a netted mass over the rocks,—while many of the smaller are parasitical or, more properly, epiphytic, growing on the fronds of the larger kinds, to which they attach themselves by minute 'sucker'-like disks. Some appear to be true parasites (*Elachisteæ* and *Myrionemata*). Several are of minute size, but very few strictly microscopic. Almost all present three regions, resembling respectively the root, stem, and leaf or leaves of the higher plants, although they are not ordinarily regarded as the morphological analogues of them. In a few cases the frond is a shapeless mass or crust, lying close to the surface of the rocks. None become calcified like the Corallines.

The *fructification* of these plants is still in a somewhat obscure condition as regards the order in general; for great apparent diversities occur in the physiological phenomena presented by what at first appear like identical structures. We have here, as in the *Florideæ*, three distinct forms of reproductive structure, known respectively as:—1, *zoospores*; 2, *spores*; and 3, *spermatozoids*.

1. The *zoospores* are the reproductive bodies most frequently met with; and in the lower forms the arrangements are not very different from those in the filamentous Confervoids. In ECTOCARPUS, where the frond is composed of jointed cellular filaments, the cells at the ends of the branches, or other articulations, become enlarged and filled with granular matter which is ultimately converted into *zoospores*. These enlarged cells are called by Thuret *sporanges*, and are commonly described as *spores* in algological works; but they burst and discharge the numerous microscopic *zoospores*, which are pear-shaped, with a clear, beak-like, narrow end, of olive colour, and have two cilia, not arising from the beak, but from a reddish point on the coloured portion; one cilium is longer than the other, and directed forwards; the other is short, and trails behind like a kind of rudder. Their movements are very active; and they seek the light. When they germinate, they become immovable and spherical, acquire a membranous coat, and emit a tubular prolongation, which soon becomes divided by cross septa, and is developed into a new frond. In some cases the sporanges are multilocular (*trichosporanges*), consisting of very slender, and usually rather short, jointed filaments, in each joint (cell) of which a single *zoospore* is produced. These occur in considerable number, occupying the same place as the unilocular kind, which they sometimes accompany; and the two forms appear to pass one into the other. The zoospores are perfectly similar, except that those produced singly in the filaments are not so large as those developed in large numbers in the large, ovate, unilocular sporanges.

The two forms of sporange producing zoospores have been found in the Myrionemaceæ, Chordariaceæ, Sporochnaceæ, Punctariaceæ, and Dictyosiphonaceæ; in *Chorda lomentaria* only the multilocular, and in the other Laminariaceæ only the unilocular, have been seen at present.

The Cutleriaceæ present the remarkable phenomenon of the occurrence of sporanges containing zoospores together with antheridia analogous to those of the FUCACEÆ. (See CUTLERIA.)

2. The *spores* occur in the Dictyotaceæ and the Fucaceæ, as large granular bodies of ovate form, enclosed in a sac or sporange (*perispore*), and clothed besides by a gelatinous coat called the *epispore*; these large spores are always devoid of power of motion. In some cases they are simple reproductive spores; in others they subdivide, after escaping from the perispore, into two, four, or eight sporules, each capable of germination. (See FUCUS, and figs. 253, 256.) In the Dictyotaceæ these spores are collected into definite groups (*sori*) on the surface of the frond. In the Fucaceæ the spores are found in spherical cavities immersed in the substance of the frond, sometimes occurring in all parts, sometimes collected in special regions. These cavities communicate with the external surface by pores, and are usually perceptible from the swollen slimy appearance where they open. Where no general receptacles exist, the little spherical chambers are excavated in the frond; where these do occur, as in *Fucus*, the spherical chambers are attached to the inside of their walls, one beneath each external pore. These chambers, called by some *scaphidia*, by others *conceptacles*, contain *spores* or *antheridia*, or both. The spores occur in sacs consisting of a cell (*perispore*) springing from the wall of the chamber. (See FUCUS.)

3. The *spermatozoids* have been met with, as well as zoospores, in the Cutleriaceæ. The *spermatozoids* (or *antherozoids*, as Thuret terms them) exactly resemble those of *Halidrys* and *Pycnophycus*, described below.

In *Dictyota* the spermatozoids occur on separate plants, in antheridia grouped in sori like the spore-fruit.

In the Fucaceæ the *spermatozoids* or antherozoids occur with the *spores* above described. In *Fucus canaliculatus* (*Pelvetia*, Dcne. and Thuret) and *F. platicarpus* (Thuret) the antheridia are found, in company with the spores, in the conceptacles; in the other species of *Fucus* the two kinds of organs are never met with together in the same conceptacle; in *Himanthalia lorea* they are on distinct plants; in *Halidrys siliquosa* intermingled, and in *Pycnophycus tuberculatus* in the same chamber, but not mixed. The antheridia of these plants consist of transparent ovoid sacs, inserted in great number on the branched hairs (*paranemata*) (fig. 254) clothing the inside of the fruit-chambers or *scaphidia*. In some genera they have a double coat, in others only one; when two exist, the inner is expelled as a sac on the rupture of the antheridium; when only one exists, the spermatozoids are expelled individually and freely from the single coat, which always remains attached upon its support. The spermatozoids or antherozoids found in these sacs are little hyaline globules, each enclosing a granule of grey colour in *Fucus canaliculatus*, red-orange in all other species of *Fucus* and other genera. They bear two locomotive cilia, very slender, and of unequal length. The form of the corpuscles and the arrangement of the cilia differ in different genera. In all the species of *Fucus* the spermatozoids are of the shape of little bottles, the neck of which, always foremost in the movement, bears the shortest cilium; the longer arises from the coloured granule, and trails behind. In *Halidrys*, *Pycnophycus*, and *Cystoseira*, the corpuscle is oval or spherical in one dimension, and compressed, sometimes a little convex, in the other; both the cilia are inserted on the red granule, and during the locomotion the corpuscle turns upon its own axis, with the longer cilium in advance, vibrating with rapidity, while the shorter is motionless. In *Himanthalia* the antheridia have a double coat; the form of the antherozoids is not clearly made out. The antherozoids of the Fucaceæ have been shown by Thuret, their discoverer, to be analogous to the spermatozoids of the higher Cryptogamia, and to perform a fertilizing function, not to reproduce the plant like the zoospores of the other families; and the multiplication appears to be effected solely by the large olive-coloured spores. (See FUCACEÆ.)

Synopsis of the Families.

FUCACEÆ. *Frond* leathery or membranous, cellular. *Fructification*: *spores* and *antheridia* contained together or separately in spherical cavities imbedded in the frond.

DICTYOTACEÆ. *Frond* cellular, flat, compact. *Fructification*: *spores*, *antheridia* (and *tetraspores* ?) arranged in definite spots or lines (*sori*) on the surface.

CUTLERIACEÆ. *Frond* cellular, compact, ribless. *Fructification*: dot-like scattered collections of *sporanges* divided into eight compartments; and *antheridia* (?) consisting of chambered filaments in groups of curved jointed hairs.

LAMINARIACEÆ. *Frond* leathery or gelatinous, cellular. *Fructification*: *unilocular sporanges* in indefinite cloud-like patches, or covering the whole surface of the frond;

or *multilocular sporanges* clothing the whole surface of the frond like an epidermis.

DICTYOSIPHONACEÆ. *Frond* cylindrical, branched, of filamentous structure. *Fructification*: ovoid *sporanges* imbedded lengthways in the substance of the frond, opening by a pore on the surface.

PUNCTARIACEÆ. *Frond* cylindrical or flat, unbranched, cellular. *Fructification*: ovate *sporanges* in groups on the surface, intermixed with clavate filaments (*paraphyses*).

SPOROCHNACEÆ. *Frond* leathery or membranous, cellular, branched. *Fructification*: *unilocular* or *multilocular sporanges* attached to external jointed filaments, free or collected in knob-like masses.

CHORDARIACEÆ. *Frond* cartilaginous or gelatinous, composed of horizontal and vertical jointed filaments interlaced. *Fructification*: *unilocular sporanges* springing from the base of the vertical filaments forming the epidermis of the frond; and *multilocular sporanges* developed later from the filaments surrounding the former.

MYRIONEMACEÆ. *Frond* tuber-shaped, crustaceous, or spreading as a crust, of filamentous structure. *Fructification*: *unilocular* and *multilocular sporanges* attached to the superficial filaments, and concealed among them.

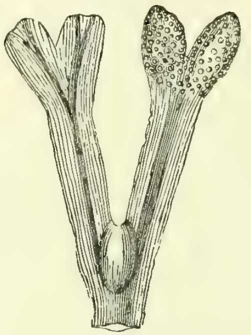
ECTOCARPACEÆ. *Frond* filiform, jointed. *Fructification*: *unilocular sporanges*, ovate sacs developed at the ends or intermediate joints of the filaments; and *multilocular sporanges*, consisting of minute jointed filaments found in similar situations. *Antheridia* with spermatozoids have been found in *Sphacelaria*.

BIBL. See that of the Families.

FU'CUS, Linn.—A genus of Fucaceæ (Fucoid Algæ), including some of the commonest and most abundant of our olive-coloured sea-weeds, growing upon rocks and stones between tide-marks, their large fronds waving in the water at high tide, and lying matted together over the rocks when the tide is out; continually cast ashore in quantities after rough weather. *F. vesiculosus*, the common *bladder-wrack*, is familiar to every one who has visited a sea-coast. Decaisne and Thuret divide the genus into three: *Pelvetia* (*F. canaliculatus*), *Ozothallia* (*F. nodosus*), and *Fucus* proper, including *F. serratus*, *vesiculosus*, and *ceranoides*.

In *F. nodosus* and *F. Mackaii* the receptacles are lateral and stalked; but in all the rest they are terminal and continuous with the frond (fig. 252), forming oval thickened

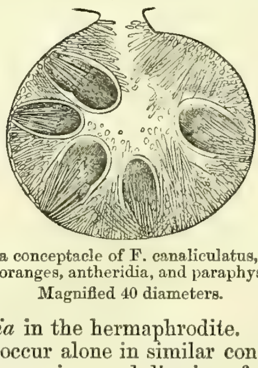
Fig. 252.



End of a branch of F. vesiculosus, bearing two terminal receptacles.
Half the nat. size.

clubs, on which, by the naked eye, may be distinguished a number of spots or pores. These are the orifices of the conceptacles, which are globular cases immersed in the substance of the receptacle, and communicating with the outer surface by a pore (fig. 253). The central portion of the receptacle is filled up with a delicate network of jointed filaments surrounded by a gelatinous substance, this medullary structure forming a bond of union between the numerous conceptacles. The internal wall of the conceptacles is lined with a dense mass of delicate jointed filaments (fig. 253) standing vertically (*paraphyses*), among which appear the stalked *spore-sacs*, alone in the diœcious and monœcious forms, mixed with

Fig 253.



Section of a conceptacle of F. canaliculatus, containing sporanges, antheridia, and paraphyses.
Magnified 40 diameters.

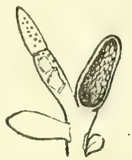
antheridia in the hermaphrodite. The *antheridia* occur alone in similar conceptacles in the monœcious and diœcious forms. *F. canaliculatus* is hermaphrodite (like *Pycno-*

phycus tuberculatus, which, however, has antheridia only at the upper part of the conceptacle, near the pore, spore-sacs at the lower part); in *F. serratus, ceranoides, vesiculosus*, and *nodosus* the male and female conceptacles occur usually on distinct plants; but both kinds sometimes occur on *F. nodosus.* The male and female individuals of the diœcious species may often be distinguished, when mature, by the yellowish colour the antheridia give to the receptacles; and if these are exposed for a short time to the air, the antheridia are expelled in masses through the pores of the conceptacles, and form little orange-coloured papillæ. The female plants under similar circumstances exhibit olive-coloured papillæ at the mouths of the pores, consisting of masses of spores.

The *sporanges* or *spore-sacs* consist of ovate sacs, stalked, on the walls of the conceptacle (fig. 253); they have a double membrane—an outer, the *sporange* or *perispore*, and an inner, the *epispore*: these are undistinguishable until the spores escape; but then the epispore becomes evident as an inner sac. The epispore encloses at first a mass of olive-coloured cell-contents; in *F. canaliculatus* (*Pelvetia*) this divides into two spores, in *F. nodosus* (*Ozothallia*) into four, and in *F. serratus, vesiculosus*, and the other *Fuci* proper, into eight, by segmentation. When mature, the *sporange* bursts at the apex; the *epispore* enclosing the spores is expelled, and makes its way towards the pore of the conceptacle, and falls into the water, where it undergoes the following modifications. Taking *F. vesiculosus* as an example, the expelled epispore encloses eight spores, forming what Thuret calls an *octospore*. This swells; and the spores become rounded, separating from each other; and the upper part of the epispore begins to dissolve. The spores become removed from the lower part of the epispore (marked by the impression of the stalk of the sporange); and it then becomes evident that they are enclosed in a third membrane, which is attached to the *epispore* in the centre of its base, so that as the spores emerge from the dissolving summit of the epispore the internal membrane becomes stretched upward, until it finally bursts and sets the spores free. These changes of the octospore are generally passed through in about an hour, sometimes much more rapidly.

The *antheridia* consist of minute ovate sacs, attached in great numbers to hair-like filaments growing from the internal surface of the conceptacle (fig. 254). When young,

Fig. 254. Fig. 255.



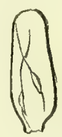


Fig. 254. A branched cell of F. nodosus, bearing a perfect and an imperfect antheridium. Magn. 200 diams.

Fig. 255. Sac of an antheridium of F. serratus, nearly empty. Magn. 400 diams.

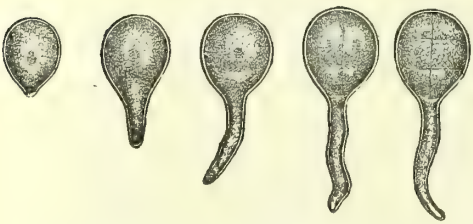
they are filled with colourless granular matter; but subsequently this becomes condensed into little corpuscles (*spermatozoids* or *antherozoids*), forming a greyish mass dotted with orange points. The sac is double; and the internal one is expelled from the outer like the epispore from the sporange, and finds its way out from the pore of the conceptacle. The spermatozoids which fill up the central part begin to move actively; and the sac soon bursts at one or both ends to discharge them. The spermatozoids (fig. 255) are excessively minute, transparent bodies, scarcely 1-5000″ long, enclosing a granule of an orange-colour in most spores, but greyish in *F. canaliculatus.* The spermatozoids have two cilia, of unequal length, one directed forwards, the other backwards; the form of the spermatozoids and the direction of the cilia vary in different species,—the one directed forward usually moving with great rapidity, and producing locomotion, while the other trails behind like a rudder.

The most interesting and important point connected with the genus *Fucus* is the process of fecundation, which has been distinctly made out by Thuret, showing the existence of sexes in the Algæ, at least in one family.

When a drop of (sea-) water containing active spermatozoids is added, upon a slide upon which the free spores above described have been previously placed, the whole operation of the fertilization may be traced under the microscope. The spermatozoids attach themselves in great numbers to the spores, and by the motion of the cilia communicate to them a rotatory movement, often very rapid. The field of the microscope becomes covered with these large brownish spheres bristling with spermatozoids, and rolling in all directions among the crowd of

those still unattached. After about half an hour, the movement of the spores ceases; the spermatozoids move for some time longer. In a few minutes after the contact of the spermatozoids, such fertilized spores will be found coated with a membrane, the presence of which is readily made out by placing the spore in syrup, which causes the granular contents to contract and shrink away from the envelope, which, moreover, may be coloured blue by sulphuric acid and iodine. The spore next begins to enlarge and grow by cell-division, one end becoming elongated into a transparent filament like a radicle (fig. 256); several more of these are

Fig. 256.



Spores of F. serratus in various stages of germination. Magnified 100 diameters.

afterwards formed as the upper part grows; and they become organs of attachment by which the young frond is fixed to a stone or other support. The above description corresponds in all essentials to the process as it occurs in the other species. The spores of *F. vesiculosus* have been fertilized with spermatozoids of *F. serratus* by Thuret; but no other experiments of hybridation were successful.

One or two other points deserve notice. The orange spot of the spermatozoids is coloured blue by sulphuric acid (like CHLOROPHYLL). Sugar and sulphuric acid colour the spermatozoids red (PROTEINE). The membrane of the sporange (*perispore*) is coloured blue by sulphuric acid and iodine (CELLULOSE); but this is not the case with the epispore nor the internal membrane, even after treatment with caustic potash. In *F. canaliculatus*, however, there is a laminated coat immediately surrounding the spores, which when placed in sea-water separate, while the coat swells and forms a kind of gelatinous envelope, which appears as if covered with cilia; these pseudo-cilia seem to be analogous to the similar appearances in the gelatinous sheath of DESMIDIACEÆ and other CONFERVOIDS.

The months from December to March are the most favourable for observing the above phenomena. No covering glass must be used on the slide, unless prevented by a thin glass support from pressing on the spores and deforming them. A power of 150 to 200 diameters suffices for most of the observations,—for the spermatozoids and the actual fecundation, a power of 300. Sea-water must always be used. The germination of the spores may be observed by placing them on glass slides moistened with sea-water, and keeping them under a bell-glass standing in a dish containing sand moistened with sea-water.

BIBL. Harvey, *Br. Mar. Alg.* p. 18, pl. 1 D; *Phyc. Brit.* pls. 47, 52, 158, 214; Greville, *Alg. Brit.* pl. 181; Decaisne and Thuret, *Ann. d. Sc. Nat.* 3 sér. iii. p. 5; Thuret, *ibid.* xvi. p. 6, 4 sér. ii. 197, vii. p. 34.

FUNA'RIA, Schreb.—A genus of Funariaceæ (Acrocarpous Mosses), the common species of which (*F. hygrometrica*) is well known on account of the hygroscopic character of its fruit-stalk, which twists in drying, and untwists again when wetted. It exhibits stomata on the neck of the capsule (fig. 262).

BIBL. Wilson, *Bryol. Brit.* p. 268; *Berkeley, Handb.* p. 176.

FUNARIACEÆ.—A family of Funarioideæ (Acrocarpous Mosses) of loosely-tufted or gregarious habit, growing on the ground; the stem loosely leaved, very simple. Inflorescence monœcious; antheridial flowers disk-shaped, mostly terminal on a special branch. Antheridia small, oval. Archegones small, narrowly apiculate. Paraphyses filiform at base, club-shaped and articulate at the apex. Peristome, if present, cartilaginous, red, streaked, with solitary, oblique, trabeculate teeth.

British Genera.

Funaria. Capsule asymmetrically arched (fig. 257); orifice oblique, very small; stalk much curved, elongated, very hygroscopic and twisting. Calyptra ventricose-dimidiate, rounded at the base, obtuse, shorter than the capsule, or larger and truncate at the base (fig. 258). Peristome double, erect; outer of sixteen, oblique, broadly lanceolate-subulate, trabeculate teeth, with appendices near the point (fig. 259), chained together at the apex by a reticular disk; the inner as many as the outer, opposite and adnate at

the base, lanceolate, granular, with a longi-

Fig. 257.

Fig. 258.

F. hibernica.

Fig. 257. A ripe capsule with its twisted seta.
Fig. 258. An immature capsule, covered by its calyptra.

Magnified 25 diameters.

Fig. 259.

F. hibernica.
Teeth of the peristome, with appendices.
Magnified 150 diameters.

tudinal line. Cells of the operculum *circinately-reticulate* at the apex.

Pyramidium. Calyptra squarely pyramidal, apiculate, entire at the base, far exceeding the capsule, totally covering it, inflated and persistent, bursting at the middle of the side, longer. Capsule symmetrical, erect, pyriform, without a peristome. Operculum *regularly areolate.*

Physcomitrium. Calyptra mitre-shaped, split at the base into several laciniæ, entire below, much shorter than the capsule, with a long apiculus. Capsule symmetrical, straight, pyriform, without a peristome. Operculum regularly areolate.

Entosthodon. Calyptra bladder-like, midiate, with a long apiculus, entire, rounded or truncate, readily splitting. Capsule symmetrical, pear-shaped, straight, or declined on an arched stalk, with or without a peristome. Peristome, if present, horizontal, erect when dry, simple; internal wanting or scarcely perceptible; composed of very short laciniæ. Teeth lanceolate, *without appendages,* simple or twin, flat outside, trabeculate within, mostly oblique at the summit, connivent but not connate. Operculum regularly areolate.

Fig. 260.

Physcomitrium pyriforme
Capsule, magn. 25 diams.

Amblyodon. Calyptra hood-like, narrow, very fugacious, longish, very slender, composed at the apex of very small, thickened, square cells. Capsule asymmetrical, pear-shaped, straight, with a peristome and an annulus. Peristome double: *external*—teeth sixteen, short, lanceolate, obtuse, erect, trabeculate with a slender longitudinal line; *internal*—teeth equal in number, lanceolate, subulate, fissile longitudinally in the middle, smooth, much exceeding the external in length, yellowish, placed on a shortly-grooved membrane. Operculum regularly areolate.

FUNARIOIDEÆ. — A suborder of operculated Acrocarpous (terminal-fruited) Mosses, with broadly-oval spathulate leaves, furnished with a lax cylindrical nerve, composed entirely of large parenchymatous cells, lax and parallelogrammic at the base, lax, hexagonal, or polygonal towards the apex, often very densely filled with chlorophyll-granules, more or less pellucid. Capsule pyriform, apophysate, the neck (*collum*) mostly bearing stomates on its epidermis (fig. 262).

Fig. 261.

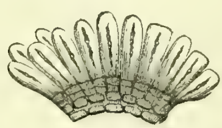
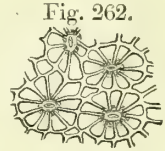


Fig. 262.



F. hygrometrica.

Fig. 261. Portion of the annulus. Magn. 100 diams.
Fig. 262. Epidermis of the collum, with stomates.
Magn. 100 diams.

This suborder is divided into two families:

FUNARIACEÆ. Stem very simple, terrestrial.

SPLACHNACEÆ. Stem very much branched, mostly occurring upon dung of animals.

FUNGI.—A class of Cellular Flowerless Plants, growing in or upon damp (vegetable) mould, in or upon the wood and the herbaceous parts of living or dead plants, upon living or decaying animal substances, in solutions of organic matters, &c. A few occur on bare stones or other inorganic substances; as a species of *Cyphella* or other Myxogastres; but this is quite exceptional. A very large portion of the plants belonging to this strange class are microscopic bodies, only to be made out clearly by means of a very high magnifying power: as in the rest of the Thallophytes, moreover, the reproductive bodies are simple and exceedingly minute in the larger forms of Fungi; and consequently dissection under the microscope is requisite when it is desired to obtain a satisfactory insight into their natural history.

The Fungi do not appear to be capable of assimilating inorganic food, and are distinguished from healthy specimens of almost all other plants by the total absence of the colour depending on the presence of chlorophyll or its red modifications; for it is scarcely to be doubted that the various colourless filamentous structures (Leptomiteæ, &c.) occurring in infusions, chemical solutions and the like, are Fungi, and not Algæ as some have supposed. They are allied by certain forms with the Algæ and with the Lichens; but they are distinguished from all outwardly similar forms of the first by the spore-bearing fruits always being elevated into the air, when mature, although the thallus or mycelium may be aquatic. The higher forms of Fungi can scarcely be confounded with the higher Algæ. The separation from the Lichens is more difficult, and promises to be still less practicable the more we know of the plants; indeed some authors have already come to the conclusion that the Lichens must be reduced to forms of Fungi. Yet the presence of green gonidial cells in the thallus will generally sufficiently distinguish the Lichens. We shall here follow the old plan; and the distinction ordinarily laid down is, that the Lichens are entirely aërial *incrusting* plants, while the Fungi have their vegetative structure *immersed* in the medium in which they grow. Some of the epiphyllous lichens, however, originate beneath the cuticle.

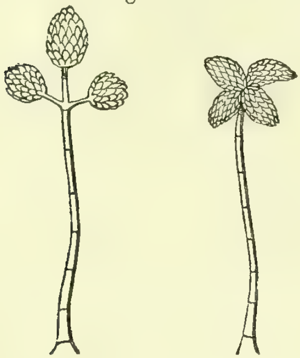
The structures of all Fungi exhibit a well-defined separation into two parts, namely:—1, a *mycelium* (thallus), or vegetative structure, consisting of a mass of exceedingly delicate, jointed and branched, colourless, interlacing filaments, forming a kind of cottony or felty mass when growing in the earth, in vegetable structures, &c., or cloudy flocks when growing in decomposing liquids. In some cases, as in certain *Sphæriæ*, the threads are woven into a close mass, or, as in *Phallus*, into filiform cords; while in the Myxogastres the threads become obsolete or are replaced by a jelly-like substance resembling sarcode; 2, of the reproductive structure or *fruit*, which, unlike the mycelium, differs extremely in appearance in the various tribes.

The *mycelium* may be well examined in the "spawn" used for planting mushroom-beds; this cottony substance consists of the mycelium of that plant. The formation and growth of the mycelium of the microscopic species, such as moulds, mildews, &c., may be traced under the microscope by scattering some of the dust-like fructifications (as the blue powder of common paste-mould) upon slips of glass, and keeping them in a warmish place under a bell-glass over water, for several days. The filaments will be seen spreading from the spores in all directions, and often advancing to the formation of the fructification.

The *fructification* of the simplest Fungi is nothing more than a modification of one or more cells at the end of a filament which rises up from the general body of the mycelium. In TORULA, one or more globular cells are produced at the ends of filaments composed of elongated, more or less cylindrical cells (Pl. 20. fig. 7); these globules drop off, and develop into new mycelia. In *Botrytis* (figs. 77, 78, 263), the tips of the fertile filaments are branched and clothed with heaps of spores arising from short pedicels. In *Penicillium* (Pl. 20. fig. 15), the filament which rises up, forks at the end, each branch forking again, and so on, until a close tufted pencil of branches is formed, each branch bearing a bead-like row of spores, which drop off separately. Innumerable modifications of this mode of fructification are met with in the microscopic Fungi; and the same plan also forms the

basis of the fructification of some of the

Fig. 263.



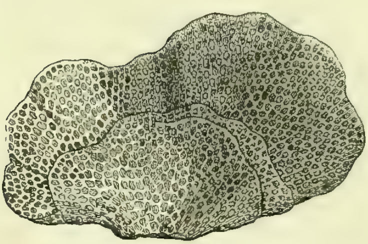
Botrytis vulgaris.
Fertile filaments. Magnified 200 diams.

highest forms. The way in which the greater complexity arises is by an increased development of the structures supporting the layer of tissue (*hymenium*) upon which the spores are borne. Thus, in the leathery Fungi growing over damp trunks of trees and dead wood, such as the *Hydna, Thelephoræ, Hexagonia* (figs. 264, 265), the con-

Fig. 264.

Hexagonia glabra.
Upper surface. Nat. size.

Fig. 265.



Hexagonia glabra. Nat. size.
Lower surface, with orifices of the hymenium.

spicuous fungous mass (which is all that ordinary observers notice) developed from a flocculent mycelium imbedded in the matrix on which the plant grows, is a *fruit*, composed of dense cellular tissue, and possessing pits, channels, cavities, or the like, the walls of which are clothed with papillose cells, each bearing four free sporanges, which drop off singly to reproduce the plant. The Mushroom, as gathered and brought to table, is merely the 'fruit' of the Fungus (*Agaricus*); and similar cells bearing four sporules are found clothing the flat sides of the paper-like plates or 'gills' which radiate on the under side of the flat 'cap' of the Fungus. (See BASIDIOSPORES.)

Another mode of fructification is met with in the Fungi; and by this they in some cases come exceedingly close to the Lichens. The simplest form of the second kind of fructification is seen in the PHYSOMYCETES, where the upright filament arising from the flocculent mycelium does not bear free spores, as in *Penicillium, Botrytis*, &c.), but a comparatively large sac, filled with minute sporules; and these sporidia are scattered by the bursting of the sac. In the *Helvellæ, Pezizæ, Spathulea* (fig. 40), *Leotia* (fig. 41), &c., structures of a fleshy or leathery character, growing upon damp wood &c., we have counterparts to the *Hydna, Thelephoræ*, &c., since they have fruits arising from a flocculent mycelium; but their spore-bearing cells appear as definite groups of vesicles or sacs of elongated form, producing sporules (usually eight but sometimes two, multiples of two, or multiples of eight) in their cavities. In the Truffles (*Tuber, Elaphomyces*, fig. 185), &c. the sporidia are found in twos, fours, or eights, in sacs in the internal convoluted substance (while in the Puff-balls, except *Scleroderma*, where the internal mass finally breaks up into powder, the spores are developed free, as in the Agarics &c.). More minute accounts of these structures will be found under THECASPORES and the various genera.

It was long imagined that these two modes of producing the spores afforded a firm basis for the classification of the Fungi; but recent discoveries seem to indicate that characters derived from the fructification are as unsafe here as in the Algæ, in the present state of our knowledge. Thus, if De Bary's observations on *Agaricus* are correct, an asciferous structure occurs in the highest group of the basidiosporous classes. It is now, however, pretty certain that the

ascigerous structure which he found on *Agaricus melleus* was a species of Hypomyces. The orders Coniomycetes and Ascomycetes also are confounded together by the numerous genera which exhibit both *asci* and *stylospores*, although the latter may perhaps be regarded as merely a modification of the ascosporous structure. Tulasne has also pointed out a peculiar structure analogous to the so-called *spermatozoids* of the Lichens, namely very minute cylindrical bodies growing upon free points from the fructifying surfaces of the Fungi; these bodies, quite distinct from the basidiospores and thecaspores, are called *spermatia* (Pl. 20. figs. 3, 4, 17*s*). The physiological relations of these various structures are as yet quite obscure; and they are dwelt upon but slightly here, from the absence of definite generalizations on the subject; they present a field for most desirable observations.

Zoospores have now been discovered in PERONOSPORA and CYATOPUS.

The minutiæ of the structure of the Fungi may be treated most satisfactorily under the heads of the orders (ASCOMYCETES, CONIOMYCETES), since the elements are very similar in all, while the modes of combination are very varied, and in most cases peculiar to the families.

The Fungi are divided by Mr. Berkeley into six orders; and as the facts which have lately come to light, throwing doubt on the validity of some of the divisions, are not yet sufficiently numerous to allow of satisfactory general conclusions, we adopt these orders as practically convenient, reserving the remarks on this subject to the description of certain families. (See SPHÆRONEMEI, SPHÆRIACEI.)

1. HYMENOMYCETES or AGARICOIDEÆ (*Mushrooms*, &c.). Mycelium floccose, bearing conspicuous fleshy fruits of various forms, which expand when perfect so as to expose the hymenium or sporiferous membrane to the air. Spores generally borne in fours on short pedicels arising from cells of the hymenium.

2. GASTEROMYCETES or LYCOPERDOIDEÆ (*Puff-balls*, &c.). Mycelium floccose, bearing usually globular or oval leathery fruits, which are at first solid, with internal convolutions clothed by the hymenium, bearing the spores in fours on distinct pedicels, the internal convoluted portions finally breaking up and constituting a pulverulent or gelatinous mass enclosed in a eathery membrane (*peridium*).

3. CONIOMYCETES or UREDOIDEÆ (*Smuts &c.*). Mycelium filamentous, parasitical, bearing usually sessile masses of (microscopic) fructification, consisting of groups of sessile or stalked spores or pseudospores, sometimes septate.

4. HYPHOMYCETES or BOTRYTOIDEÆ (*Mildews &c.*) (Microscopic). Mycelium filamentous, epiphytic, producing erect filaments bearing terminal, free, single, simple or septate spores.

5. ASCOMYCETES or HELVELLOIDEÆ (*Truffles, Morells, &c.*). Mycelium inconspicuous, bearing fleshy, leathery, horny, or gelatinous, lobed or wart-like fructifications, containing internally, or on the surface, groups of elongated sacs (*asci* or *thecæ*), in the interior of which the sporidia (generally eight) are developed.

6. PHYSOMYCETES or MUCOROIDEÆ (*Moulds*). Mycelium (microscopic) filamentous, bearing stalked sacs containing numerous spores or sporidia.

BIBL. Berkeley, *Fungales*, Lindley's *Veg. Kingd.*, *Fungi*, in Hooker's *British Flora* and *Cryptogamic Botany*; also numerous papers in the *Ann. Nat. Hist.*; Montagne, *Organ. and Phys. Sketch of Fungi*, transl. by Berkeley in *Ann. Nat. Hist.* vol. ix.; Corda, *Icon. Fung.* Prague, 1837–40; Greville, *Scott. Cryptog. Flora*; Nees v. Esenbeck, *Syst. Pilze*; Fries, *Syst. Mycolog.*; *Summa Veget. Scan.* See also the BIBL. of the families.

FUNGUS-BED.—Mycologists find this very useful for growing the microscopic Fungi. It is best made of a small wooden box half-filled with damp bog-earth, and covered with a plate of glass. In winter it should be kept in a warm room.

FURCELLA'RIA, Lamx.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one common British species, growing on rocks and stones between tide-marks, consisting of a fastigiate, dichotomously-divided frond, 6 to 12″ high, of a brownish-purple colour, and somewhat cartilaginous texture. The tetraspores, which are linearly arranged, are imbedded in the periphery of the swollen pod-like extremities of the branches. Conceptacular fruit as yet unknown.

BIBL. Harvey, *Br. Mar. Alg.* p. 147, pl. 18 C; *Phyc. Brit.* pl. 94; Greville, *Alg. Brit.* pl. 11; *Eng. Bot.* pl. 894.

FURCULARIA, Lam.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye single, frontal; tail-like foot

forked. Several species; all aquatic but one, which is marine.

F. Reinhardtii, E. (Pl. 34. fig. 34; fig. 35, teeth). Body fusiform, truncated in front; foot elongate, cylindrical; toes two, short; length 1-120′′.

Found creeping upon *Laomedea geniculata*.

F. gibba. Body oblong, slightly compressed, dorsally convex, ventrally flat; toes styliform, half as long as the body; length 1-96′′. Aquatic.

Bibl. Ehrenb. *Infus.* p. 419; Dujardin, *Infus.* p. 648; Gosse, *Ann. N. H.* 1851, viii. p. 199.

FUSA'RIUM, Lk.—A genus of Stilbacei (Hyphomycetous Fungi), not very satisfactorily distinguished from Fusisporium, but having a firm, cellular, pulvinate, fleshy stroma, upon which the spores are borne on distinct sporophores, glued together into an erumpent discoid stratum. *F. tremelloides* is common, forming roundish orange-red spots on decaying nettle-stems; but it is now believed to be a spore-bearing state of *Peziza fusarioides*. *F. roseum* forms little gregarious red dots on the stems of beans, Jerusalem artichokes, and other plants.

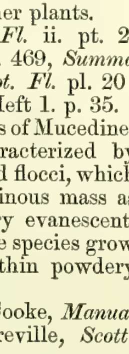
Bibl. Berk. *Hook. Brit. Fl.* ii. pt. 2. p. 355; Fries, *Syst. Myc.* iii. 469, *Summa Veg.* 472; Greville, *Sc. Crypt. Fl.* pl. 20; Fresenius, *Beitr. zur Mycol.* Heft 1. p. 35.

FUSID'IUM, Lk.—A genus of Mucedinei (Hyphomycetous Fungi) characterized by very delicate white or coloured flocci, which do not form a moist or gelatinous mass as in *Fusisporium*, and are very evanescent. Spores straight, filiform. The species grow on dead leaves, forming a thin powdery stratum.

Bibl. *Berk. Outl.* p. 357; Cooke, *Manual of Brit. Fung.* p. 609; Greville, *Scott. Crypt. Fl.* t. 102.

FUSISPO'RIUM, Lk.—A genus of Sepedoniei (Hyphomycetous Fungi), growing upon vegetable substances often when decaying, characterized by elongate fusiform curved septate spores (fig. 266), which ultimately form a gelatinous mass, the flocci being in general more or less obscure, or if present very delicate, the spores in fact forming the principal element. Numerous species are recorded as British. *F. atrovirens* is destructive to onions. *F. betæ* common on decaying mangold-wurzel. *F. fœni* sometimes runs over the cut surface of a haystack, forming broad orange-red patches.

Fig. 266.



Fusisporium. Spores. Magn. 400 diams.

Bibl. Berk. *Hook. Brit. Fl.* ii. pt. 2. p. 251, *Ann. N. H.* vi. p. 438, pl. 14. fig. 28; 2 ser. vii. p. 178; Fries, *Syst. Myc.* iii. p. 442, *Sum. Veget.* p. 473; Greville, *Sc. Crypt. Fl.* pl. 102. figs. 1 & 2.

FUSULI'NA, Fisch.—A genus of spiral, hyaline Foraminifera, near *Nonionina* and *Nummulina*, but fusiform instead of nautiloid, the umbilical axis of the shell being much extended. The lateral tapering elongations of the chambers in some cases are simple, yielding symmetrical casts figured by Ehrenberg as *Borelis* in the 'Mikrogeologie;' but in others the chambers are divided throughout by labyrinthic segmentation, giving more complex casts and sections.

F. cylindrica (Pl. 47. f. 15) and its varieties form enormous masses of limestone in the Carboniferous system in Russia and North America.

Bibl. Carpenter, *Introd. Foram.* 304; *M. Microsc. Journ.* 1870, p. 180.

G.

GALLIONEL'LA, Bory. = Melosira, Agardh. *Gall. ferruginea* = Didymohelix.

GALLS.—These are abnormal growths, tumours as they might be called, produced upon or in vegetables by the action of animals, especially insects of the order Hymenoptera. They are supposed to arise from the irritation caused by a poisonous liquid discharged into the orifice made by the insect for the introduction of its egg. At all events a convergence of the nutritive juices towards the wound takes place, whence results a kind of hypertrophy of the tissues, and frequently the accumulation of such substances as starch in the cells. The forms may be regular or irregular; most of them are characteristic, as, for example, the well-known nut-gall, the oak-apple, the bedeguar of the rose, &c. Both cellular and vascular structures contribute to form the substance of galls. We cannot enter into their minute structure here, but refer to an elaborate paper by Dr. Lacaze-Duthiers. See Aphidæ and Cynipidæ.

Bibl. Lacaze-Duthiers, *Ann. d. Sc. Nat.* 3 sér. xix. 273, where also the earlier literature is given.

GALUM'NA, Heyden, Gervais.—A genus of Arachnida, of the order Acarina, and family Oribatea.

Char. Abdomen subglobular, depressed;

sides of the pseudo-thorax forming a salient or wing-like angle; legs of moderate length.

This genus approximates to *Belba*.

The three species, the bodies of which are of a blackish, blackish-chestnut, or ash-colour, are found on mosses.

BIBL. Walckenaer, *Arachn.* (Gervais); Hermann, *Mém. Aptér.* p. 91; Koch, *Deutschl. Crustac.* &c.

GAMA'SEA.—A family of Arachnida, of the order Acarina.

Characterized by the free filiform palpi, the chelate mandibles, and the legs with two claws and a caruncle. Generally parasitic, and found on insects and birds; some upon fishes, reptiles, and mammals.

Dermanyssus. Body soft; last joint of palpi smallest; labium acute; mandibles—of male, chelate, outer claw very long,—of female, ensiform; legs with two claws and a caruncle, anterior longest, coxæ approximate. On birds and bats (Pl. 2. fig. 24).

Gamasus. Labium trifid; body with usually two dorsal plates; anterior legs generally longest, second pair sometimes incrassate; no eyes. On insects, &c. (Pl. 2. fig. 26).

Pteroptus. Body depressed; last joint of palpi longest; legs stout, with short joints. On bats (Pl. 2. fig. 39).

Uropoda. Body depressed, with a round dorsal plate, and a deciduous funnel-shaped anal peduncle, serving to fix the body. On beetles, mosses, &c. (Pl. 2. fig. 25).

Halarachne. Body elongate, with a dorsal and ventral plate; labium bifid. In the nostrils of a seal (*Halichœrus*).

See also ARGAS and CARIS.

BIBL. Gervais, *Walckenaer's Apt.* iii. 215; Dugès, *Ann. des Sc. Nat.* 2 sér. 24; Koch, *Deutsch. Crustac.* &c.; V. d. Hoeven, *Zool.* i. 558.

GAM'ASUS, Latr.—A genus of Arachnida, of the order Acarina, and family GAMASEA.

Species numerous; mostly parasitic upon insects; some found upon the ground; others on animals.

G. coleoptratorum (Pl. 2. fig. 26). Found upon dung-beetles (*Geotrupes* &c.). Anterior coxæ attached at a little distance from those of the second pair; tarsi (fig. 26 *a*) with two claws and an elegant caruncle; palpi of moderate length; mandibles terminated by a curved hook.

G. marginatus. Found in the human brain; also on a fly.

G. telarius, the hot-house red spider; reddish, with two black spots on abdomen.

G. muscarum. On the house-fly.

G. auris. In aural meatus of ox.

BIBL. That of the family; Leidy, *Proc. Acad. Phil.* 1872 (*Ann. N. H.* 1873, xi. p. 79).

GAM'MARUS, Latr.—A genus of Crustacea, of the order Amphipoda, and family Gammarina.

The searcher for the freshwater Diatomaceæ will surely meet with *Gammarus pulex* (Pl. 43. fig. 22), the freshwater shrimp, in muddy brooks and streams. It attains a length of about 1-2″, and moves its curved body through the water by means of its caudal appendages, frequently lying on its back or side during the process. Gervais distinguishes *G. fluviatilis* from *G. pulex*, by the former having a dorsal spine at each abdominal joint, whilst in the latter this is absent.

There are twenty-three species of *Gammarus*, many of them marine. *Talitrus saltator*, the sand-hopper, found burrowing in and hopping upon the sand of the sea-shore, also belongs to the family *Gammarina.*

BIBL. Desmarest, *Consid. gén. s. l. Crust.*; M.-Edwards, *Crustac.* iii.; Gervais, *Ann. des Sc. Nat.* 1835, iv.; Westwood, *Phil. Trans.* 1835; Bate and Westwood, *Ann. Nat. Hist.* 1857, xix. p. 135.

GANGLION-GLOBULES, or NERVE-CELLS. See NERVES.

GARVEI'A, T. S. Wright.—A genus of Hydroid Polypes, Fam. Atractylidæ.

G. nutans. Body red, tentacles yellow; marine; height 1″. On rocks and sea-weeds.

BIBL. Hincks, *Brit. Zooph.* p. 101.

GASTEROMYCE'TES.—An order of Fungi, characterized by the production of their free spores upon basidia seated on a sporiferous structure forming convolutions in the interior of an excavated fruit, which ultimately bursts to allow the sporiferous structure to expand and scatter its spores. The fruit of the Gasteromycetes is ordinarily a globular, elliptical, or shapeless mass, varying in size from microscopic minuteness to the dimensions of large leather balls, often stalked, arising from an inconspicuous flocculent mycelium. This external body consists of a leathery or membranous, simple or double sac (*peridium*), which bursts in various ways at maturity. When examined young, these Fungi appear solid; but as they advance, various structures become gradually marked out in their interior, and appear more and more distinct until mature.

In the Nidulariacei little *conceptacles* are developed in the interior of the sac-like pe-

ridium; and when the latter is mature, it opens like a cup or vase at its summit, exhibiting the conceptacles within, lying like eggs in a nest. These conceptacles are hollow, and lined with basidia bearing free spores.

The Myxogastres are minute Fungi growing upon wood, leaves, &c., and looking at first to the naked eye like patches of froth. The early development of this group is not satisfactorily made out; De Bary has recently published a most remarkable paper respecting it (see MYXOGASTRES). The mucous or frothy masses ultimately dry up and leave little sessile or stalked capsules or conceptacles (figs. 145, 147). At maturity, the conceptacles, which are sacs, and consist of a double *peridium*, burst and emit the sporiferous structure, which often rises from the conceptacle and expands in various forms. The sporiferous structure is called the *capillitium*, and consists of a collection of simple or anastomosing filaments, either attached to the peridium—and forming a kind of network, from between the meshes of which (probably the seat of their development) the spores fall out—or free and discharged with the spores. The free filaments of several genera are marked with striæ, which in TRICHIA may be clearly seen to arise from a spiral fibrous structure like that of the elaters of the Hepaticaceæ.

The Trichogastres exhibit in most cases the appearance of a leather ball, arising

Fig. 268.

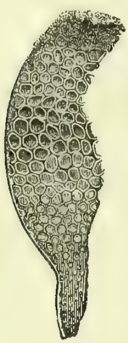
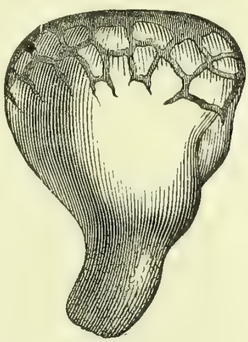


Fig. 267.

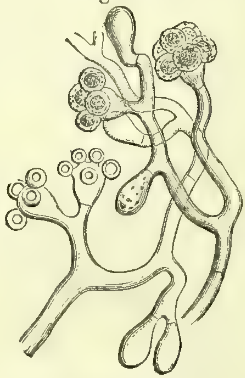


Polysaccum crassipes.

Fig. 267. Natural size.
Fig. 268. Section from ditto, showing the loculi

from an inconspicuous flocculent mycelium; but in *Broomeia* the sporanges are imbedded in large numbers in a common fleshy matrix. The internal structure differs to a considerable extent in its earlier stages. The *peridium* is either single or double, the inner being often quite free, and becoming everted at the time of dehiscence. The interior of *Polysaccum* (fig. 268) and *Scleroderma* (fig. 270) consists, in the early state, of a mass of

Fig. 269.



Polysaccum crassipes.
Cells of the hymenium, with basidia and spores.
Magn. 400 diams.

Fig. 270.

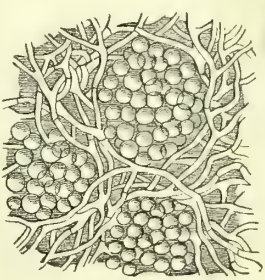
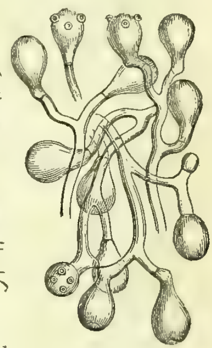


Fig. 271.



Scleroderma vulgare.

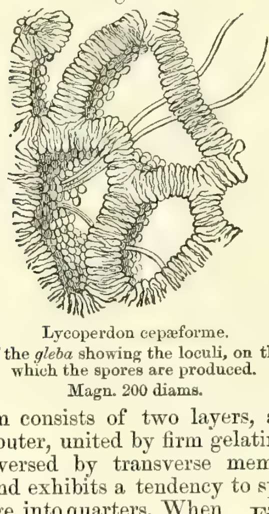
Fig. 270. Portion of the internal mass. Magn. 200 diams.
Fig. 271. Cells of the hymenium, with basidia and spores. Magn. 400 diams.

structure formed by the prolongation of the peridium, in the form of septa, in all directions into the interior, so as to divide it into chambers, each of which contains a nucleus of filamentous cellular substance, or conceptacle, hollow in the centre, into which project the ends of the filaments, bearing basidia with two to six spores. At the epoch of maturity all the internal structure has vanished, except the spores and detach[illegible] [illegible]r-

ticles of the filaments on which they were developed; and these escape on the bursting of the now bag-like peridium, as a fine powder. In *Lycoperdon*, &c., it is not the peridium which is continued inwards to form chambers; it forms a single or double sac, containing a fleshy substance (*gleba*), hollowed out into sinuous cavities clothed with basidia. In course of ripening, the spongy mass disappears, leaving only a collection of minute spores and filamentous fragments, which are emitted by the bursting of the peridium,—a process exhibiting many curious peculiarities in this group.

The Phalloidei are roundish or ovoid fleshy balls in their earlier stages, but when opened exhibit a distinct *peridium* and a central lacunose sporiferous structure. The

Fig. 272.



Lycoperdon cepæforme.
Section of the *gleba* showing the loculi, on the walls of which the spores are produced.
Magn. 200 diams.

peridium consists of two layers, an inner and an outer, united by firm gelatinous tissue traversed by transverse membranous septa, and exhibits a tendency to split, like an orange, into quarters. When the peridium bursts, which it usually does at the apex, the central sporiferous structure emerges, under various forms. In *Phallus* it is a capitate or clavate column; in *Clathrus* (fig. 273), an elegant, globular, fleshy trellis; in *Aseroe*, a column with a stellate head, &c. In all cases, the spores, which are developed on convolutions of the fleshy sporiferous mass (*gleba*), on basidia, are found detached and confluent into a wet viscid mass adhering to the sporiferous surface at the time

Fig. 273.

Clathrus cancellatus.
The sporiferous frame-work emerged from the ruptured peridium.
1-10th nat. size.

this has emerged from the peridium and expanded to its full size. This wet condition of the mature sporiferous layer is distinctive between the Phalloidei and the *Hymenomycetes*, to which they bear many relations.

The Hypogæi receive their name from their subterraneous habit of growth, in which they resemble Truffles, a tribe of Ascomycetes bearing much external similarity to these plants (see TUBERACEI). The general character is that of globular or de-

Fig. 274. Fig. 275.

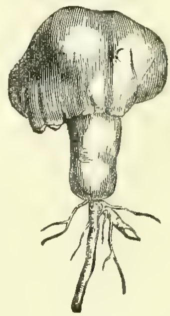
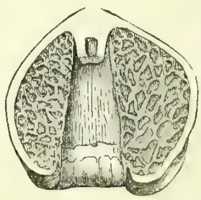
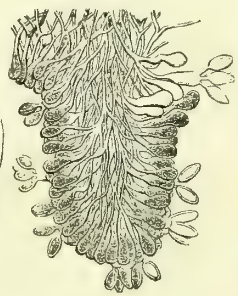


Fig. 276. Fig. 277.





Secotium erythrocephalum.

Fig. 274. Natural size.
Fig. 275. Vertical section.
Fig. 276. Vertical section through the head, showing the labyrinthiform cavities.
Fig. 277. Portion of a septum dividing the loculi, bearing basidia. Magnified 400 diameters.

pressed balls, growing underground, sessile on a flocculent mycelium. They exhibit a peridium enclosing a fleshy *gleba*, excavated into sinuous cavities lined by a membrane bearing basidiospores. These fruits do not burst, but set free their spores by decaying.

Lastly, the Podaxinei bear much resemblance to the Trichogastres; but they always contain a central fleshy column, called the

hymenophore. The young plants exhibit a peridium passing internally into a fleshy mass hollowed into labyrinthiform cavities (fig. 275), with a solid column in the centre of all. The cavities are lined by a membrane bearing basidiospores (fig. 277). The *gleba* sometimes breaks up into a pulverulent mass of spores and filaments; sometimes it is permanent. The internal structure of this order presents many points of great morphological interest, but rather as regards the mode of arrangement and composition of the tissues than the character of the ultimate elements themselves, which consist of the ordinary filamentous interwoven tissue of Fungi in the general mass of the structure, and of globular loosely packed cells in the sporiferous regions.

Synopsis of the Families.

1. PODAXINEI. *Peridium* dehiscent, enclosing a sinuously excavated, fleshy, sporiferous mass, falling to powder or permanent when mature, with a central solid column.

2. HYPOGÆI. *Peridium* indehiscent, coating a fleshy, sporiferous mass. Subterraneous.

3. PHALLOIDEI. *Peridium* dehiscent, enclosing a fleshy sporiferous mass, which emerges from the burst peridium as a club-shaped or capitate column, or a globular network of wrinkled fleshy processes, coated on the sporiferous surfaces with a dark-coloured foul-smelling slime (composed of minute spores imbedded in mucus).

4. TRICHOGASTRES. *Peridium* double, more or less distinct, dehiscent, enclosing a multilocular, fleshy, sporiferous mass, which finally breaks up into dust, without a central column.

5. MYXOGASTRES. *Peridium* at first developed from a mucilaginous matrix, sac-like, dehiscent, emitting a reticulated filamentous structure bearing the spores. (Minute, almost microscopic Fungi.)

6. NIDULARIACEI. *Peridium* dehiscent, and then forming a cup or nest, containing one or many globose, oval or discoid conceptacles, lined with filaments bearing spores.

BIBL. See the Families.

GASTROCHÆ'TA, Duj.—A genus of Infusoria, of the family Enchelia (Duj.).

Char. Body oval, with one side convex, the other being traversed by a longitudinal furrow, which is furnished with vibratile cilia principally at the ends.

G. fissa (Pl. 24. fig. 7). Body semitransparent, colourless, oval, truncated in front with a very minute blunt point at the middle of the posterior margin, convex and smooth above. Aquatic; length 1–400″.

BIBL. Dujardin, *Infus.* p. 385.

GAUDRYI'NA, D'Orb.—A Textilarian Foraminifer, having the early chambers arranged triserially, as in a *Verneuilina,* making the shell three-keeled at first; but it subsequently becomes compressed and wrinkled, the chambers being alternate with biserial growth, as in *Textilaria.* The aperture is usually, as in *Textilaria,* a slit on the inner wall of the chamber; but it may be almost terminal and somewhat rounded and pouting, thus passing into *Heterostomella.* Some *Gaudryinæ* are twisted and Buliminoid. Fossil and recent. Pl. 18. fig. 48, *G. pupoides,* D'Orb. In the Chalk.

BIBL. D'Orb. *For. Foss. Vien.*; Parker & Jones, *Annals N. H.* 3, xi. 127.

GELATINE.—This chemical proximate principle constitutes the basis of the various forms of white fibrous tissue, as existing in the true skin, areolar tissue, tendon, ligaments, the swimming-bladder of fishes (isinglass), &c.

It possesses no microscopic characters; it forms a most valuable vehicle for the colouring-matters of liquids for injection.

BIBL. See CHEMISTRY.

GELID'IUM, Lamx.—A genus of Cryptonemiaceæ (Florideous Algæ), of which one species (*G. corneum*) is very common on our shores. It has a red, pinnated, horny frond, from two to six or eight inches high; very variable in the appearance of its pinnate subdivisions; both spores and tetraspores are found on the ramules, the former in favellidia immersed in swollen ramules.

BIBL. Harvey, *Brit. Mar. Alg.* p. 137, pl. 17 B, *Phyc. Brit.* pl. 53.

GEMELLA'RIA, Sav.—A genus of Cheilostomatous Polyzoa, of the order Infundibulata, and family Gemellariadæ.

G. loriculata (Pl. 44. fig. 26). Cells inversely conical, obliquely truncate. Common a few fathoms below low water-mark.

BIBL. That of the family.

GEMELLA'RIADÆ.—A family of Cheilostomatous Polyzoa, of the order Infundibulata.

Distinguished by the unjointed polypidom, and the cells being opposite in pairs. Two genera:

1. *Gemellaria.* Cells joined back to back, all the pairs facing the same way; orifice oval, oblique; no birds'-heads (Pl. 44. fig. 26).

2. *Notamia.* Each pair of cells arising from the next pair but one below it by tubular prolongations; pipe-shaped birds'-heads above each pair (Pl. 44. fig. 21).

BIBL. Johnston, *Brit. Zooph.* 293; Busk, *Mar. Polyzoa*, 34; Gosse, *Mar. Zool.* ii. 14.

GEMMÆ.—This term is applied to those cellular structures, formed in Flowerless Plants, which become detached, and reproduce the individual independently of the spores.

GEMMULI'NA, D'Orb. See BIGENERINA.

GENERATIONS, ALTERNATION OF.—The general plan upon which the reproduction of animals is effected, viz. that of sexes, involving the action of the spermatic secretion upon the ova, and the subsequent series of changes ultimately giving rise to new individuals resembling the parents, is in some instances departed from; and the embryos of certain animals, after their escape from the ova, do not become directly developed into individuals resembling the parents, but produce a new, larval kind of being, which produces generations of the same larval or other kinds, the last of which resemble the original parents.

While, therefore, in animals reproduced by the ordinary sexual process, the new individuals resemble each other, or differ only in sex, in those which produce these alternate or intermediate generations the new individuals differ from the parents and even from each other, until the last of the series returns to the state of the first parents. This mode of reproduction has received the above name, from the alternation of the larval generations with the ordinary sexual form.

Many instances of this process are mentioned under the heads of the Classes, &c. in which they occur; as under ACALEPHÆ, APHIDÆ, ENTOZOA, TÆNIA, &c. Thus, for instance, in the Acalephæ, the ciliated embryo (Pl. 40. fig. 6) produced by the ordinary sexual process becomes fixed (fig. 7), and passes into the state of an asexual polype (fig. 8); it then reproduces new individuals from gemmæ and stolons (fig. 9), ultimately becoming segmented (fig. 10), and producing new individuals which resemble the sexual parents. The intermediate or nurse forms are those represented in figs. 7–10. Again, in *Tænia*, the *Cysticercus* or *Echinococcus* forms the nurse, producing new individuals by gemmation, these, on reaching the alimentary canal, becoming transformed into *Tæniæ* with sexual organs.

But the alternation of generations, or a modification of it, also occurs in animals in which sexes are not known to exist, as in some Infusoria. In these, the ordinary plan of reproduction by division and gemmation is departed from, and an animal differing from the parent, or a nurse-form resembling or identical with *Acineta* and *Actinophrys*, is produced, which gives rise to embryos subsequently growing into the parent form. But in these instances the nurse-form is the result of a kind of metamorphosis, rather than of generation.

The phenomena designated by the phrase alternation of generations are also strikingly exemplified in the vegetable kingdom; but the conditions are very complicated, and the analogies with those occurring in animals somewhat difficult to trace. The Mosses, Hepaticæ and Ferns afford very clear analogies to the Medusæ; and others admit of being made out; but it appears to us that Steenstrup and others have confounded various distinct points, in the parallel drawn between the alternation of generations of animals and the metamorphoses (commonly so-called) of plants. We will endeavour to give a summary of the general facts connected with the doctrine.

1. All animals and plants reproduced by a sexual process (and there is reason to believe that this will ultimately be found universal), originate from a simple protoplast or cell, and undergo a series of changes, in the course of their development to the complete form endowed with sexual organs, in which they assume forms analogous to animals (or plants) belonging to classes of lower (simpler) organization.

2. In the highest animals, the metamorphoses are *intra-uterine*, as in most of the Mammalia; in the lower animals these metamorphoses are in part or wholly *extra-uterine*. In the higher plants the changes are partly *intra-uterine* (*i. e.* the embryo has already become a leafy axis within the ovary, but it becomes perfected into the sexual form subsequently), in the lower partly or wholly *extra-uterine*.

3. The lower animals and all plants are capable of an asexual or vegetative reproduction, by the isolation and separation of a portion of their substance.

4. Many animals and all plants are capable of being multiplied by this vegetative reproduction in their intermediate stages of extra-uterine development; and in such cases the reproduction, fissiparous, gemmiparous, or other, assumes the character peculiar to

the class to which the intermediate form is analogous (*ex. gr.* the polypiform reproduction of the Acalephæ, the confervoid growth and multiplication of the proembryo of the Mosses). The product of the vegetative reproduction is either like or unlike the body which produces it: in the former case the vegetative reproduction will be repeated; but in the latter case the product is usually provided with sexual organs, and the cycle of development is completed by the reproduction of a fertilized ovum. In the latter case we have what is called an *alternation of generations.*

It will be evident that we here exclude from consideration the metamorphoses within the sphere of the individual *shoot* on plants—that is, the metamorphosis of the leaf, the morphological element of the higher plant. It appears to us that these are not to be taken as parallels to the metamorphoses of animals comprehended by Steenstrup under the name of alternation of generations, which would rather be found in the cases where bulbs, bulbils, tubers, &c. appear in the place of shoots, as the product of branch-buds. The analogy would hold also with the *gemmæ* of the Mosses, &c., and with the *gonidia* of the Thallophytes. Our space does not admit of a more minute examination of the subject. Illustrations of the phenomena in vegetables will be found under FERNS, MOSSES, CONFERVOIDEÆ, LICHENS, certain Fungi, *e. g.* ERYSIPHE, PENICILLIUM, &c. See also PARTHENOGENESIS.

BIBL. Steenstrup, *Altern. of Gen.* (*Ray Soc.* 1845); Owen, *Parthenogenesis*, and *Ann. N. H.* 1851, ii. 59; A. Thomson, *Cycl. Anat.* iv. *Suppl.*; Huxley, *Ann. N. H.* 1851, viii. p. 1, *Brit. and For. Med. Rev.* 1854, i. 204; A. Braun, *Rejuv.* (*Ray. Soc.* 1853); Henfrey, *Ann. N. H.* 2 ser. ix. p. 441; Radlkofer, *Befrucht.* 1857, *Ann. N. H.* 2 ser. xx. p. 241; Huxley, *Linn. Tr.* xxii. p. 218; Leuckart (*Cecidomyia larvæ*), *Ann. N. H.* xvii. 1866, 161.

GENERATION, SPONTANEOUS; sometimes called equivocal generation, epigenesis, or heterogeny.

The doct.ine of spontaneous generation was considered to have become a matter of history. We noticed under AIR (p. 22), the experiments which were supposed to have negatived the idea that microscopic plants and animals derive their origin from the direct transformation of decaying animal and vegetable remains. We have also there stated the modes by which the lower forms of organic life, most commonly found in decomposing infusions, propagate with extraordinary rapidity. But these experiments have since been repeated by numerous observers with directly opposite results.

The other two principal instances which were supposed to favour the doctrine of spontaneous generation, were the production of the Spermatozoa and of the Entozoa.

It need scarcely be remarked that the Spermatozoa cannot be regarded as animals; they are products of the metamorphosis of the contents of cells (SPERMATOZOA, SPERMATOZOIDS); and the only ground for considering them animals was based upon their power of motion, which we now know to be no exclusive character of animality. The supposed occurrence of particular species of Entozoa within the bodies of other animals, not to be found in any other situations, would naturally appear to find a ready explanation in the doctrine in question. Later investigations, however, have proved that these supposed species are larval or other forms of true species of this Class, which do not attain their perfect development on account of their not existing in a suitable locality.

See GENERATIONS, ALTERNATION OF.

BIBL. Schultz, *Pogg. Annal.* xli. p. 184; Helmholtz, *Journ. f. Prak. Chem.* xxxi. 429; Gross, *Sieb. und Köll. Zeits.* iii. p. 68; Reissek, *Ber. Wien*, 1851; Pineau, *Ann. d. Sc. Nat., Zool.* 1845. 1848; Pasteur, *Ann. Sc. Nat.* 1861, *Zool.* xvi. p. 5. p. 312; *Compt. Rend.* 1860, li. pp. 348, 675; id. *Compt. Rend.* 1861, lii. p. 1142; Pouchet, *Hétérogénie*, 1859; id. *Nouv. Exp. &c.* 1864; Bastian, *Beginnings of Life*, 1872; *Evolution of Life*, *Med. Press and Circular*, 1872.

GENICULA'RIA, De Bary.—A genus of Desmidiaceæ.

Char. Cells cylindrical, elongate, neither constricted nor incised, united into long filaments. Endochrome forming 2 or 3 spirals (left-handed). Conjugating joints geniculate.

G. spirotænia. Cells slightly expanded at the ends, cell-walls rough. Frankfort.

BIBL. De Bary, *Conjug.* p. 77; Rabenhorst, *Fl. Alg.* iii. p. 156; Pritchard, *Inf.* pl. 3. fig. 31.

GEODIA, Lamk.—A genus of marine sponges. Distinguished by the rounded form, the solid structure permeated by sinuous canals, and the solid external crustaceous covering formed of globules of flint.

G. Zetlandica. Deep water.

Bibl. Bowerbank, *Brit. Spong.* ii. 45.

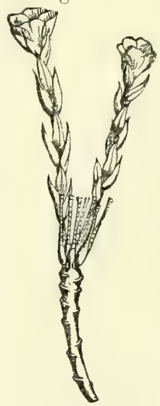
GEOLOGY.—The utility of the microscopic investigation of geological products is treated of under Rocks.

GEOPH'ILUS, Leach.—A genus of Insects, of the order Myriapoda.

G. longicornis, with the body brown, slender, consisting of more than 40 joints, is common in gardens, under flower-pots, &c. See Myriapoda.

GEOR'GIA, Ehrh.—A genus of Mniaceous Mosses, called, from the four teeth of the peristome, *Tetraphis* and *Tetradontium*; but these names are of later date than Ehrhart's (1780). *G. Mnemosyne* presents, besides its male and female inflorescence, a peculiar form of terminal leafy bud (fig. 278), which produces stalked gemmæ in the interior. In the figure numerous archegonia are also shown.

Fig. 278.



Georgia Mnemosyne. A shoot with two terminal leafy buds. Magn. 15 diameters.

Georgia Browniana, C. Müller, = *Tetraphis Brown.,* Grev.

G. Mnemosyne, Ehrh. = *Tetraphis pellucida,* Hedw.

GEPHYR'IA, Arn.—A genus of Diatomaceæ.

Char.—Fr. arcuate, attached, destitute of cellulate annuli and septa; hoop sublamellate, finely striate. Valves arcuate, with one median and several lateral costæ, dissimilar; inferior with the costæ disappearing below the ends of the valve; superior with them reaching the summit.

G. incurvata. Ichaboe and Patagonian guano.

G. media. Californian guano.

G. Telfairiæ. Mauritius.

Bibl. Arnott, *Qu. Micr. Journ.* viii. p. 20; Greville, *Micr. Trans.* 1866, pp. 77, 122 (fig.)

GERA'NIUM.—In this genus, and apparently in the rest of the Nat. Ord. Geraniaceæ, the sepals are remarkable for the cells containing numerous raphides regularly arranged. They may be observed in the common *G. Robertianum* and in the garden *Pelargonia.* The sepals of the common wild Geraniums form pleasing objects when dried and mounted in Canada balsam.

Bibl. Quekett, *Ann. N. H.* xviii. p. 82.

GER'DA, Cl. & L.—A genus of Infusoria, fam. Vorticellina.

Char. Sessile, resembling *Scyphidia,* but distinguished by the absence of the posterior sphincter or sucker.

G. glans (Pl. 48. fig. 2).—Body elongate, cylindrical or clavate behind; contractile vesicle posterior, continued into a long vessel. Aquatic.

Bibl. Clap. and Lachm. *Infus.* p. 117.

GERMINAL VESICLE of Animals. See Ovum.

GERMINAL VESICLE of Plants.—This structure, the existence of which is now universally admitted by physiological botanists, is the germ of the future plant, formed from one of the protoplasmic *germ-masses* which exist before impregnation (Tulasne is doubtful whether before) in the embryo-sac of Flowering Plants. In most cases three masses are originally produced, as in *Orchis* (Pl. 38. fig. 4); and in rare instances two of these are fertilized, and two embryos produced in one seed; sometimes only one exists, and ordinarily only one is fertilized. This becomes at first elongated into a cellular filament called the *suspensor,* which is cut off by septa into several cells, the last of which ordinarily becomes the *embryonal vesicle* or *embryo-cell,* which is then developed into the embryo (fig. 192. page 269). See Ovule and Embryo.

GERMINATION.—The act of development of a seed or spore into a new plant. The phenomena attending the germination of all the Cryptogamic plants require the aid of the microscope for their investigation, and are in most instances highly interesting and important in a physiological point of view. For particulars, see the classes of Flowerless Plants.

GER'RIS, Latr.—A genus of Hemipterous (Heteropterous) Insects, of the family Hydrometridæ.

Gerris lacustris is everywhere seen skimming the surface of water. It has the basal joint of the antennæ longest, the four hind legs very long and at a great distance from the fore legs. The legs do not possess any special structure by which they are enabled to repel the water, beyond a number of short hairs.

Velia rivulorum, with the basal joint of the antennæ longest, the legs of moderate length and equally apart, and *Hydrometra stagnorum,* with the first and second joints of the antennæ short, the third being the

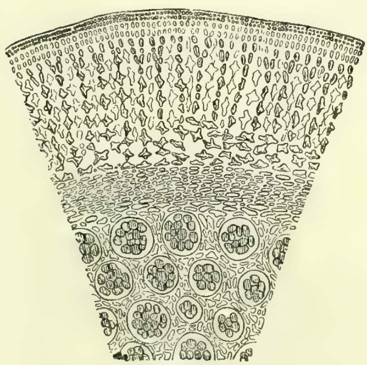
longest, are allied members of the same family, and are commonly met with on the surface of pools, &c. The elegantly sculptured eggs, and the curiously placed eyes of *Hydrometra*, are interesting objects.

In the anterior tarsi of *Velia*, minute membranous retractile lobes have been described.

BIBL. Westwood, *Introd.* ii. 467, and *Syn.* 119; Douglas and Scott, *Brit. Hemipt.*

GIGART'INA, Lamx.—A genus of Cryptonemiaceæ (Florideous Algæ), with cartilaginous irregularly-divided fronds, the internal substance of which is composed of rather lax tissue, the outer of dichotomous filaments perpendicular to the surface, strongly united by their moniliform terminations (fig. 279). Four British species are

Fig. 279.



Gigartina pistillata.
Transverse section of the frond.
Magnified 50 diameters.

known, growing from 2 to 6 inches high, of a dull purple colour. Reproduced by spores (in favellidia) and tetraspores scattered among the peripheral filaments.

BIBL. Harvey, *Mar. Algæ*, 139, pl. 17 C; Greville, *Alg. Brit.* pp. 146, 147, pl. 16.

GILLS OF FISHES.—The organs form beautiful and favourite injected objects. They must be injected from the heart, or from the branchial artery, which ascends from the heart much in the same manner as the pulmonary artery ascends from the heart of the higher animals. It may be remarked that the heart of fishes is situated much nearer to the anterior end of the body than in the Mammalia.

BIBL. Stannius, *Vergl. Anat.*; Lereboullet, *Anat. Comp. de l'Appar. Respir.*; Hyrtl, *Med. Jahrbücher der Œster. Staat.* bd. 24; Owen, *Hunterian Lect.* ii.; Leydig, *Histol.* 382.

GILLS OF INSECTS, or branchiæ.—These are hair- or leaf-like processes (Pl. 28. figs. 2 *g*, 15, 19, 31) projecting from the surface of the body, and containing one or more tracheæ and their ramifications, which communicate with those of the body generally. Insects furnished with gills or branchiæ have no occasion to rise to the surface of the water in which they live, the diffusion by which the respiratory process is effected taking place between the gaseous contents of the tracheæ and those of the water.

GINAN'NIA, Montagne.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one British species, *G. furcellata*, a rare, pinky-red sea-weed, about 2 to 6 inches long, with a dichotomous, terete, membranaceo-gelatinous frond, the divisions of which have a kind of fibrous axis. The spores are produced in spherical conceptacles imbedded just beneath the surface of the frond.

BIBL. Harvey, *Brit. Mar. Alg.* p. 148, pl. 19 C; *E. Botany*, pl. 1881.

GINGER.—This substance finds a place here on account of its liability to adulteration when sold in the form of powder. It consists of the rhizomes of *Zingiber officinale* (N. O. Zingiberaceæ). The bulk of the structure consists of parenchymatous cellular tissue with pitted walls, containing scattered starch-granules, and here and there filled with a combined mass of starch-granules and yellow colouring-matter of very distinct character; besides these occur the pitted ducts and a small quantity of woody fibre. The starch-grains nearly resemble those of the species of *Curcuma* which yield East-India arrowroot. Adulteration is effected with cheap starches (sago-, wheat-, or potato-flour), which may be detected by the form of the granules, while MUSTARD-husks and CAYENNE pepper are employed to give pungency to the same reduced articles. The characters of these substances are given under their respective heads.

BIBL. Hassall, *Food &c.* p. 390.

GLANDS OF ANIMALS.—Glands are organs, the general function of which is to separate from the blood certain compounds destined to perform some special office in the economy. They are divided into true or secernent glands; and vascular glands.

The secernent glands, the secretions from

which escape either by rupture, or through ducts, are thus arranged:

1. Glands consisting of closed vesicles which dehisce laterally: the Graafian vesicles of the ovary, and the follicles (Nabothian) of the cervix uteri.

2. Glands composed of cells reticularly united: the liver. (See LIVER.)

3. Racemose or aggregated glands, in which aggregations of roundish or elongated glandular vesicles occur at the ends of the excretory ducts. These are either, *a*, simple, with one or but few lobules, comprising the mucous glands, the sebaceous and the Meibomian follicles; or, *b*, compound, with many lobules, the lacrymal and salivary glands, the pancreas, the prostate, Cowper's and the mammary glands; in this category must also be placed the lungs.

4. Tubular glands, in which the secreting elements have a more or less tubular form. These are either, *a*, simple, consisting of one or but few cæcal tubes—including the tubular gastric and intestinal (Lieberkühn's), the uterine, sudoriparous and ceruminous glands; or, *b*, compound, consisting of numerous reticular or ramified glandular canals —comprising the testis and the kidney.

The vascular glands, which have no ducts, and the contents of which escape by transudation, are subdivided into—

1. Those composed of larger and smaller cells imbedded in a stroma of areolar tissue; comprising the supra-renal capsules, and the anterior lobules of the pineal gland.

2. The closed follicles, consisting of a basement-membrane, an epithelial lining, and transparent contents, forming the thyroid gland.

3. The closed follicles, with a capsule of areolar tissue and contents consisting of nuclei, cells, and liquid, to which belong, *a*, the solitary follicles of the stomach and intestines; *b*, the aggregated follicles of the small intestines or Peyer's glands, in animals also those of the stomach and large intestines; *c*, the glandular follicles of the root of the tongue, and of the pharynx and the tonsils; and, *d*, the lymphatic glands.

4. Here belongs the spleen, consisting of a cellular parenchyma containing numerous closed follicles like the last.

5. The thymus gland, in which aggregated glandular vesicles open into a common closed canal or wide space.

The glands are further noticed under their respective heads.

BIBL. Kölliker, *Mik. Anat.*, and *Gewebelehre, &c.*; Henle, *Allgem. Anat.*; Wagner, *Handw. d. Phys.*; Todd and Bowman, *Phys. Anat. of Man*; Frey, *Histologie*, p. 493.

GLANDS OF PLANTS.—The glands of plants are special structures formed of cellular tissue, in which are produced secretions of various kinds, such as oils, resins, &c. They are ordinarily more or less closely connected with the epidermal tissues, but not in all cases, the latter instances forming a kind of transition to the receptacles of special secretions, turpentine-reservoirs &c., found in the interior of the stems of many plants. Glands may be conveniently divided into *external* and *internal*; the former are sessile, or stalked (when they present the character of glandular *hairs*, of various forms), while the latter are generally visible externally as transparent dots scattered over an organ, such as a leaf, giving it the appearance of having been pricked all over with a pin; when of more considerable dimensions, and with thicker walls, they produce tuberculation of the surface, as on the rind of the orange, &c.

External glands. These may be subdivided into simple and compound.

Simple external glands are either sessile vesicles or hairs, composed of a single vesicular or elongated epidermal cell filled with secretion; or they are hairs composed of a simple row of cells, one or more of which are filled with secretion. Examples of this may be found in the epidermis of *Primula sinensis*, *Gilia tricolor*, *Erodium cicutarium*, *Achimenes* (Pl. 21. fig. 32), *Stachys*, *Marrubium*, *Digitalis purpurea* (Pl. 21. fig. 33), *Antirrhinum majus* (Pl. 21. fig. 34), *Œnothera*, *Helleborus fœtidus*, *Scrophularia nodosa* (Pl. 21. fig. 41), *Sempervivum*, *Salvia*, *Thymus*, *Mellissa*, *Mesembryanthemum*, Garden Chrysanthemum (Pl. 21. fig. 30), &c.

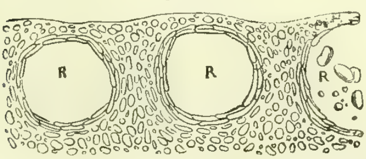
The stings of the nettles are to be placed here; they consist of very long, tapering, single hairs, with an obtuse point, and a bulb-like expansion at the base, imbedded in a dense layer of epidermal tissue (Pl. 21. fig. 8). The hair is filled with the poisonous secretion. When the point touches the skin, it breaks off and allows the escape of the fluid contents, which are squeezed out by the pressure, and probably by the tension of the tissue around the bulb.

Compound external glands differ from the simple only in the fact that they are composed of a greater or a smaller number of cells combined into a mass, usually of spherical or allied form. They may be sessile, or

stalked upon a simple or compound hair. Examples of *sessile* form occur in *Dictamnus albus* (Pl. 21. figs. 38, 39), *Robinia viscosa*, the leaf of the Mulberry and the Hop (Pl. 21. fig. 14), and the stipular glands of *Cinchona*, *Galium*, &c.; of the *stalked*, in the Rose (Pl. 21. fig. 46), species of *Rubus*, *Drosera*, and on many aromatic or viscid plants.

Internal glands. These consist of cavities in the subepidermal tissue, of variable size, bounded by a firm layer of cells, and filled with oily or resinous secretions. They appear to be formed either of one cell, when small, or, when large, of a definite mass of cells, which, after the production of the secretion, have their walls obliterated so as to form a large chamber; possibly, however, some may be intercellular spaces into which the secretion is poured out. Examples of moderate dimensions are found in the leaves of *Dictamnus*, *Magnolia* (Pl. 21. fig. 12), *Hypericum perforatum*, and other species, *Myrtaceæ*, *Ruta graveolens* (Pl. 21. fig. 11), &c. Very large glands of this kind contain the oil in the rind of the orange (fig. 280) and other species of *Citrus*.

Fig. 280.



Section of the rind of an orange, showing the internal glands, R, R.
Magn. 50 diams.

The *nectaries* of flowers have their tissue metamorphosed into a condition resembling that of the secreting part of glands; and the hairs of the stigma of Flowering Plants produce a secretion at the period of impregnation. Brongniart has lately pointed out the existence of internal glands in the dissepiments of the ovaries of the petaloid Monocotyledons. These structures form a transition to the turpentine-canals, &c. of the Coniferæ. (See Secreting organs of Plants.) The *Gummi-Keulen* of Meyen (*cystolithes* of Weddell) are also related to glands. (See Raphides.)

Bibl. Meyen, *Secretionsorg. d. Pflanzen.* Berlin, 1857; *Manuals of Vegetable Anat.*; Brongniart, *Ann. d. Sc. Nat.* 4 sér. ii. p. 5; Lawson, *Ann. N. H.* 2 ser. xiv. p. 161; Trécul, *Ann. d. Sc. Nat.* 4 sér. iii. p. 303; *Ann. N. H.* 2 ser. xvi. p. 146.

GLANDULI'NA, D'Orb.—A Nodosarian Foraminifer. It has a free, regular, straight, ovoid-globular shell; globular, almost completely embracing chambers, the last being convex and prolonged; and a round, minute, terminal orifice.

G. lævigata (Pl. 18. fig. 28). Recent and fossil. Common in the Lias and Chalk.

Bibl. D'Orbigny, *For. Foss. Vien.* 28; Morris, *Brit. Foss.* 36; Parker and Jones, *Ann. N. H.* 2 ser. xix. p. 280.

GLAUCO'MA, Ehr.—A genus of Infusoria, of the family Trachelina, E.

Char. Body ciliated all over; mouth longitudinal, oval, without teeth, placed laterally near the anterior third or fourth of the body, and furnished with one or two tremulous laminæ or lips.

Stein describes the encysting process as occurring in one species.

1. *G. scintillans*, E. (Pl. 24. fig. 8). Body colourless, slightly depressed, elliptical or ovate; sacculi large; length 1-290". Aquatic, and in infusions (of hay, &c).

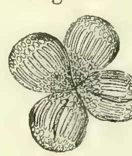
2. *G. viridis*, D. Body green, oval; mouth large, nearer the middle than the anterior end of the body; length 1-630". In putrid rain-water collected in an empty wine-cask coated with cream of tartar.

Bibl. Ehrenb. *Infus.* p. 334; Dujardin, *Infus.* 475; Stein, *Infus.* 250.

GLEICHE'NIEÆ.—A family of Polypodiaceous Ferns, distinguished by their

Fig. 281.

Fig. 282.



Gleichenia.

Fig. 281. Fertile pinnules with sori. Magn. 5 diams.
Fig. 282. Sorus composed of four crucially arranged capsules. Magn. 40 diams.

obliquely annulated sporangia arranged in fours (fig. 282). Genera:

1. *Gleichenia.* Sporangia collected in

roundish sori. Indusium absent. Leaves forking. Exotic (figs. 281 & 282).

2. *Platyzoma.* Sporanges collected in point-like sori. Indusium spurious, formed by the revolute margin of the leaf. Leaves undivided.

GLENODIN'IUM, Ehr.—A genus of Infusoria, of the family Peridinæa.

Char. Carapace membranous, rounded or oblong, with one or more distinct furrows furnished with vibratile cilia; an elongated or horse-shoe-shaped red (eye-) spot present; no horn-like processes.

These organisms are doubtful Infusoria. They are common in pools and bog-water.

1. *G. cinctum* (Pl. 24. fig. 10 *a, b*). Ovate or subglobose, ends obtuse, yellow; carapace smooth, eye-spot large, transverse and semilunar; length 1-576″.

2. *G. apiculatum* (Pl. 24. fig. 10 *c*). Oval, ends obtuse, greenish yellow; carapace smooth; eye-spot oblong; length 1-480″.

3. *G. tabulatum.* Oval, greenish yellow; carapace granular, reticulated with prominent lines; ends acute or denticulate; eye-spot oblong; length 1-480″.

Bibl. Ehrenberg, *Infus.* p. 257; Dujardin, *Infus.* p. 373.

GLENOM'ORUM, Ehr.—The *Glenomorum tingens* of Ehrenberg (Pl. 24. fig. 14), which consists of aggregated revolving groups of green bodies, with two anterior cilia, and a red (eye-) spot, has been shown by Weise and Stein to form the young state of Chlorogonium, which itself appears probably to be a stage of development of Protococcus.

GLENOPH'ORA, Ehr. — A genus of Rotatoria, of the family Ichthydina.

Char. Free; eyes two, frontal; rotatory organ circular and frontal; tail truncated, without toes.

G. trochus (Pl. 34. fig. 36). Body ovato-conical, colourless, the turgid front and the narrowed foot truncated; eyes blackish; length 1-576″; aquatic.

Bibl. Ehrenb. *Infus.* p. 391.

GLENOS'PORA, Berk. & Desm.—A genus of Dematiei (?) (Hyphomycetous Fungi), of which one species (*G. Thwaitesii*) appears to have been found in Britain.

Bibl. Berk. *Hort. Journal,* iv. p. 256.

GLOBIGERI'NA, D'Orb.—A typical Foraminifer. The shell is minute and globose, consisting of a series of ten or less globular chambers, arranged spirally in two or three whorls, and increasing rapidly from 1-2000 to 1-80″ in diameter. Surface foraminated and rugose, sometimes prickly. Each chamber opens into the umbilical hollow by a crescentic orifice. In *G. cretacea* and *G. hirsuta* the shell is almost discoidal and nautiloid; in *G. bulloides* (Pl. 47. figs. 2, 3) the chambers become heaped; in *G. helicina* the later chambers expand and grow irregular. In some cases the last chamber overlaps all the others, and the shell becomes an *Orbulina.*

G. bulloides is very abundant in the Atlantic and other oceans, also in the shallow water of the Adriatic. Many varieties occur, recent and fossil, from the Triassic period to the present day.

Bibl. Williamson, *Brit. For.* 56; Carpenter, *Introd. For.* 181; Parker and Jones, *Phil. Tr.* 1865, 365.

GLOBULI'NA, Turp. = Glœocapsa.

GLOBULI'NA, D'Orb. See Polymorphina.

GLOBULINE.—An amorphous animal substance nearly allied to albumen, existing within the coloured corpuscles of the blood and the crystalline lens.

Bibl. See Chemistry, animal.

GLŒOCAP'SA, Kütz.—A genus of Palmellaceæ (Confervoid Algæ), instituted by Kützing to receive certain forms, distributed among *Hæmatococcus, Microcystis, Sorospora,* &c. by various authors. As we have adopted it, it is distinguished from *Palmella* by the persistence of the coats of the parent-cells as envelopes enclosing their progeny of several generations, to the number of 4, 16, 64, or more secondary-cells, the membranes becoming confluent subsequently, however, by solution, into a gelatinous mass. From *Coccochloris* the chief distinction seems to be in the persistence of the lamellæ of the parent-cells in the membranous condition, and the globular instead of cylindrical or elliptical form of the cells, while the habit is to form rather flat irregular strata than globose or papillose masses. From *Protococcus* it is distinguished by the persistent gelatinous investment. Some recent writers, especially Sachs, assume that the species of *Glœocapsa* are early stages of development of Lichens, from gonidia.

We give such of Kützing's species as are British, with the synonyms as stated by him; but they require further investigation.

G. confluens. Stratum gelatinous, green. Diam. of cell-contents, 1-1200 to 1-600″. = *Hæmatococcus minutissimus,* Hassall ?

G. montana. Stratum gelatinous, green; vesicles concentrically striated; cell-contents

1-1000 to 1-500‴ in diam. = *H. microsporus*, Hass.

G. granosa. Stratum green, firm; vesicles concentrically striated; cell-contents 1-300‴ in diam. = *H. granosus*, Hass.

G. polydermatica (Pl. 3. fig. 4). Stratum hardish, olivaceous, somewhat compact or granular; concentric lamellæ evident, thick; cell-contents 1-800 to 1-500‴ in diam. = *H. rupestris*, Hass.

G. æruginosa. Stratum grey-æruginous, granular-crustaceous; vesicles large (1-100 to 1-60‴), irregular; cell-contents 1-1000 to 1-600‴. = *H. æruginosus*, Hass.

G. livida. Stratum dirty olive or blackish, soft, but tubercular; cell-contents æruginous; 1-700‴. *H. lividus*, Hass.

G. Magma. Stratum purplish-black, crustaceous, granular; cell-contents 1-500 to 1-320‴. *Sorospora montana*, Hass.

G. sanguinea. Stratum black; internal cells deep blood-red; cell-contents 1-600 to 1-400‴. = *Hæmatococcus sanguineus*, Ag., Hass.

G. Shuttleworthiana. Stratum dirty red; internal cells orange; cell-contents 1-1000 to 1-900‴.

G. Ralfsiana. Stratum dirty purple; internal cells rosy-purple; cell-contents 1-750 to 1-400‴. = *Sorospora Ralfsii*, Hass.

In Pl. 3. fig. 13 is represented a form we have met with among freshwater Algæ, which appears to agree with Kützing's *G. ampla.*

Those resting forms of *Euglena* where the encysted groups are devoid of a firm outer coat, bear considerable resemblance to a large *Glœocapsa.*

Robenhorst describes 55 European species.

Bibl. Kützing, *Phyc. gen.* p. 173, *Sp. Alg.* 216, *Tab. Phyc.* pls. 19 *et seq.*; Hassall, *Brit. Freshw. Algæ*, pl. 79, &c.; Sachs, *Bot. Zeit.* xiii. p. 1; Al. Braun, *Rejuv. &c.* (*Ray Soc.* 1853), p. 131, 182; Rabenhorst, *Fl. Alg.* ii. p. 34.

GLŒOCOC'CUS, Al. Braun.—A genus of Palmellaceæ, consisting of active biciliated gonidia resembling the moving form of *Protococcus*, but connected into families by a mass of soft jelly. See Palmellaceæ.

Bibl. A. Braun, *Verjüngung*, p. 169; *Rejuv. &c.* (*Ray Soc.* 1853), p. 159; *Ueb. Chytridien*, p. 57; Rabenhorst, *Fl. Alg.* iii. p. 36 (fig.).

GLŒOCYS'TIS, Nägeli. See Palmellaceæ.

GLŒONE'MA, Ag. } —Names of Diatomaceous genera
GLOIONEMA, Ag. } no longer retained. See Encyonema.

GLŒOSPO'RIUM, Montagne.—A genus of Sphæronemei (Coniomycetous Fungi) developed beneath the surface of leaves, and bursting through, forming a kind of rust on the surface.

1. *G. paradoxum* (*Myxosporium paradoxum*, De Notar.) occurs on ivy.

2. *G. Labes. Asteroma Labes*, Berk. *Brit. Fungi.*

3. *G. concentricum* (*Cylindrosporum concentricum*, Grev. *Sc. Crypt. Flor.* p. 27) forms a white rust upon cabbage-leaves.

Bibl. Berk. & Br. *Ann. Nat. Hist.* 2 ser. v. p. 455; Berkeley, *Hort. Trans.* vi. p. 121.

GLŒO'THEA, Nägeli. See Palmellaceæ.

GLOIOSIPHO'NIA, Carm.—A genus of Cryptonemiaceæ (Florideous Algæ), the single British representative of which is a rare, feathery, red sea-weed, 3–12 inches high, with a semigelatinous tubular frond. The spores are in dense masses, scattered among the radiating jointed filaments which clothe the periphery of the branches.

Bibl. Harvey, *Brit. Mar. Alg.* p. 152, pl. 21 A, *Eng. Bot.* pl. 1219.

GLYCERINE is the sweet principle of the fats. It may be prepared by boiling any fat, as tallow, butter, olive oil, &c., with oxide of lead and water, the water being from time to time removed, and replaced by fresh. The aqueous solutions are freed from the lead by sulphuretted hydrogen, the filtered liquid evaporated to the consistence of a syrup, and finally *in vacuo* over sulphuric acid. It is sold in the shops.

Glycerine, when pure, is a colourless, highly refractive, syrupy liquid, of a sweet taste; it mixes in all proportions with alcohol and water, but it is insoluble in ether. The property possessed by glycerine, of constituting a liquid which does not become dry, and mixes with water, renders it very useful for the preservation of microscopic objects, especially those which will not permit of being dried, such as preparations of vegetable structure, which may be left on a slide in a drop of glycerine, with a glass cover to exclude dust, for weeks and months without alteration. It renders objects very transparent, which is sometimes advantageous, sometimes the reverse. A solution of gum-arabic in diluted glycerine is an invaluable substitute for balsam for mounting objects which do not bear drying. The solution is made by dissolving 1 oz. of very clean gum in 1 oz. of water, and adding subsequently 1 oz. of glycerine: great care must

be taken, in incorporating the glycerine, to avoid forming air-bubbles, which are difficult to get rid of on account of the viscidity of the fluid. The mode of mounting objects is to soak them in pure glycerine, and then to operate as with Canada balsam, only not applying heat.

GLYCIPH'AGUS, Hering.—A subgenus of ACARUS.

GLYPHIDIEÆ.—A family of Gymnocarpous Lichens, containing one British genus, CHIODECTON.

GLY'PHIS, Ach.—A genus of Lichens.

G. labyrinthica, on trees, very rare.

BIBL. Leighton, *Lich.-Flora*, p. 403.

GLYPHODES'MIS, Grev.—A genus of Diatomaceæ.

Char. Fr. united into a filament; side view naviculoid, with a central nodule, median line, and transverse rows of granules; structure clathrate (?), the granules being developed within square areolæ, arranged in parallel rows.

G. eximia. In scrapings of marine shells. Jamaica.

BIBL. Greville, *Qu. Mic. Jn.* 1862, p. 234 (figs.).

GLYPHODIS'CUS, Grev.—A genus of Diatomaceæ.

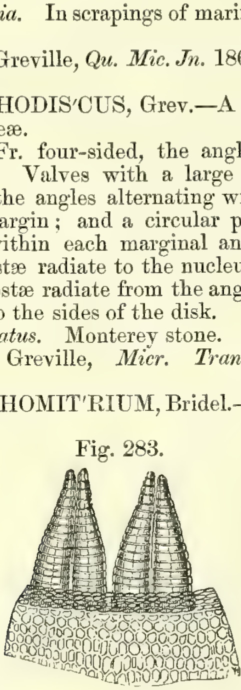
Char. Fr. four-sided, the angles much rounded. Valves with a large 4-angled nucleus, the angles alternating with those of the margin; and a circular prominent process within each marginal angle, from which costæ radiate to the nucleus; while similar costæ radiate from the angles of the nucleus to the sides of the disk.

G. stellatus. Monterey stone.

BIBL. Greville, *Micr. Trans.* 1862, p. 91.

GLYPHOMIT'RIUM, Bridel.—A genus

Fig. 283.



Glyphomitrium Daviesii.
Teeth of the peristome. Magnified 150 diams.

of Orthotrichaceous Mosses, deriving its name from the grooved calyptra. *Glyphomitrium Daviesii*, Brid. is found in Wales and Ireland on rocks, mostly near the sea. It is peculiar to Great Britain and Ireland.

GNAT. See CULEX and CULICIDÆ.

GNETA'CEÆ.—An order of Flowering Plants, remarkable for their jointed stems, composed of ducts and wood-cells marked like the wood of Conifers. The rind and pith, also, contain curious branched liber-cells.

GOMPHIL'LUS, Nyl.—A genus of Lichens.

G. calycioides. On mosses, rare.

BIBL. Leighton, *Lich.-Flora*, p. 51.

GOMPHOGRAM'MA, Braun.—A genus of Diatomaceæ, cohort Fragilariæ.

Char. Frustules solitary or geminate, front view tabellar, with interrupted clavate longitudinal vittæ, ends internally dentate; valves ovate or elliptic-lanceolate, with transverse continuous costæ.

G. rupestre (Pl. 48. fig. 3). On moist rocks (aquatic).

BIBL. Rabenhorst, *Fl. Alg.* i. p. 116; and p. 12 (fig).

GOMPHONE'MA, Ag.—A genus of Diatomaceæ.

Char. Frustules mostly single or binate, attached by a filiform stipes, wedge-shaped in front view; valves with a median line and a nodule at the centre and at each end, and striated with transverse or slightly radiating granular striæ. Aquatic and fossil.

Conjugation has been observed in several species.

Kützing describes thirty-eight species, Smith admits twelve as British. The form of the frustule is subject to great variety: and the specific characters are probably of little value.

The most common species are:—

G. acuminatum (Pl. 12. fig. 34 *a*, *b*, *c*). Frustules in front view simply cuneate, or inflated in the middle; valves attenuated at the base, ventricose in the middle, beyond which they are again expanded; ends acuminate, or truncate with an acuminate prolongation; striæ distinct; length of frustules 1-360″. (San Fiore deposit.)

G. geminatum. Valves ventricose in the middle, constricted and rotundo-truncate towards each end; striæ distinct; stalks long, thick, densely interwoven; length of frustules 1-216 to 1-180″.

G. olivaceum. Densely crowded, forming a mucous mass; frustules broadly cuneate (fr. v.); valves obovato-lanceolate; striæ distinct; length of frustules 1-1020″.

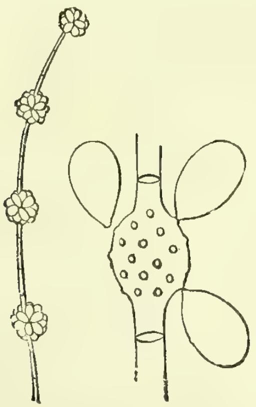
G. curvatum. Frustules curved; valves obovato-lanceolate; striæ faint; length 1-720″.

BIBL. Ehr. *Infus.* p. 215; Kützing, *Bacill.* p. 84, and *Sp. Alg.* p. 63; Smith, *Brit. Diatom.* p. 77; Ralfs, *Ann. N. H.* 1843, xvi. p. 459.

GOMPHOSPHÆ'RIA, Kütz. See PALMELLACEÆ.

GONATOBO'TRYS, Corda.—A genus of Mucedines (Hyphomycetous Fungi), the fertile filaments of which present at intervals swollen articulations, on which are attached simple ovate spores (figs. 284, 285).

Fig. 284. Fig. 285.



Gonatobotrys simplex.

Fig. 284. A fertile filament. Magn. 100 diams.
Fig. 285. A sporiferous joint, with most of the spores removed. Magn. 600 diams.

BIBL. Corda, *Icones Fungorum.*

GONATO'RRHODON, Corda. — A genus of Mucedines (Hyphomycetous Fungi), the fertile filaments of which have at intervals swollen articulations, whence arise moniliform chains of spores (fig. 286).

BIBL. Corda, *Prachtfl. Europ. Schimmelb.* pl. 3.

Fig. 286.

Gonatorrhodon speciosum.

Fertile filaments with swollen joints bearing chains of spores. Magn. 100 diams.

GONATOZY'GON, De Bary.—A genus of Diatomaceæ.

Char. Cells cylindrical or truncate-fusiform, neither constricted nor incised, united into long fragile filaments; endochrome simple, undulate and twisted.

2 species; aquatic.

BIBL. Rabenhorst, *Flor. Alg.* iii. p. 155.

GONIACY'PRIS, B. & R.—A minute Ostracod, with yellowish, compressed, triangular valves, found in the rivers and dykes of Eastern England.

BIBL. Brady and Robertson, *Ann. N. H.* s. 4. vi. 15.

GONID'IA.—The name applied to cells which in the Thallophytes perform an office analogous to that of the GEMMÆ of the higher Cryptogams, and the separating bud-structures, such as bulbils, stolons, &c. of the Flowering Plants,—being cells developed from the vegetative tissues, ultimately thrown off, and capable of propagating the individual. The gonidia of the Lichens are globular cells with green contents, developed in the central layers of the thallus, afterwards set free by the destruction of the cortical layer; they appear capable of multiplication by subdivision before growing out into the filaments which form the foundation of the new thallus (see LICHENS). And the endochrome has lately been observed in a few Lichens to be resolved into zoospores, a circumstance which brings Lichens in an important point still nearer to Fungi. The gonidia of the Fungi are usually termed CONIDIA (see that article, and FUNGI). The gonidia of the Algæ are best known in the CONFERVOIDS, where they are formed from the cell-contents, and generally present themselves ciliated, as ZOOSPORES. The tetraspores of the Florideæ are probably the homologues of gonidia.

GONIONE'MA, Nyl.—A genus of Lichens, fam. Collemacei.

G. velutinum. On subalpine rocks; rare.

BIBL. Leighton, *Lich. Fl.* p. 11.

GONIOTHE'CIUM, Ehr.—A genus of fossil Diatomaceæ.

Char. Frustules terete, with a median (longitudinal) constriction (suddenly attenuate and truncate at the ends, hence appearing angular).

Corresponds to *Pyxidicula*, constricted in the middle, and truncate at the ends.

Found in America.

We have figured several of the nine or ten species, some of which do not appear to have the characters of the genus.

G. Anaulus (Pl. 42. fig. 18); *G. barbatum* (Pl. 42. fig. 19); *G. didymum* (Pl. 42. fig. 20);

G. monodon (Pl. 42. fig. 21); *G. navicula* (Pl. 42. fig. 22); *G. Rogersii* (Pl. 42. fig. 23); *G. gastridium* (Pl. 41. fig. 40); *G. odontella* (Pl. 41. fig. 44).

BIBL. Ehrenberg, *Abh. d. Berl. Akad.* 1841. p. 401, *Berl. Ber.* 1844, p. 82, and *Mikrogeol.*; Kützing, *Bacill.* p. 51, and *Sp. Alg.* p. 23; Greville, *Mic. Tr.* 1865, p. 56.

GO'NIUM, Müller.—A genus of Volvocineæ (Confervoid Algæ), forming microscopic, square, flat fronds, either ciliated and endowed with a power of motion, or devoid of cilia and motionless; it is possible that these two conditions are only stages of development in species active at one time and resting at another. The perfect fronds are composed of usually sixteen cells, enclosed in wide colourless coats (young fronds but four cells, some kinds have more than sixteen) united together into flat square masses by adherence at various points of their circumference. A light vacuole in the substance of the cell-contents may often be observed to exhibit a rhythmical contraction and expansion, as in *Volvox*. The cells of the active forms have each a pair of vibratile cilia, which run out from the central protoplasmic mass, through the hyaline envelope, and project as free processes, rowing the frond about in the water. They are commonly observed to increase by division, a frond composed of sixteen cells breaking up into four fronds, each composed of four cells, &c.; but it is probable that other kinds of development exist, and that the motionless forms are *resting* states of active species. *Gonium pectorale* is an exceedingly interesting microscopic object, not uncommon in freshwater pools. Ehrenberg, who regards them as Infusoria, describes the following species.

G. pectorale (Pl. 3. fig. 11). Frond square, composed of sixteen bright-green cell-masses enclosed in hyaline envelopes, each with a pair of cilia; size of green masses 1-1960 to 1-1150″; frond not exceeding 1-280″. In clear water, salt and fresh, near the surface.

G. punctatum. Cells sixteen; cell-masses green, with black granules; diam. 1-4600″; frond of sixteen, 1-576″.

G. tranquillum (Pl. 3. fig. 12). Cells sixteen; cell-masses green, diam. 1-2880″; frond of sixteen, 1-144 to 1-288″, sometimes twice as broad as long; the cell-masses found in division (binate or quaternate), motionless (Possibly not a *Gonium*, but a Palmellacean—*Tetraspora*?).

G. hyalinum. Cell-masses hyaline, diam. 1-3000″; frond of twenty or twenty-five, 1-600″. In stagnant water.

G. glaucum. Cell-masses bluish green, from four to sixty-four in a frond, diam. 1-7000 to 1-4200″, ditto of frond not exceeding 1-570″. In sea-water.

The remarkable organism SARCINA resembles the motionless *Gonia* in appearance, being, however, cubical instead of tabular; but its peculiar habit would rather lead to its being placed among the Fungi. The genus TETRASPORA among the Palmellaceæ is closely related here. MERISMOPÆDIA seems to be an unnecessary genus, as the species may fall under one or other of these.

BIBL. Ehrenberg, *Infus.* p. 55; Cohn, *Nova Acta*, xxiv. p. 169, pl. 18; Fresenius, *Mus. Senckenb. Gesell.* ii. p. 187, 1856.

GONOTHYRÆ'A, Allman.—A genus of Hydroid Polypi, fam. Campanulariidæ. 2 species.

G. Loveni (*Laomedia dichotoma*, Johnson), on the fronds of the large sea-weeds, and on stones, at low-water mark.

BIBL. Hincks, *Hydroid Zooph.* p. 180.

GOR'DIUS, Linn.—A genus of Entozoa.

Char. Body very long and slender, filiform; alimentary canal with a single orifice; sexes distinct.

G. aquaticus, the common hair-worm, is from 7 to 10″ in length and about 1-25 to 1-20″ in breadth, of a brown or blackish colour, and is found in water or damp places. The mouth is very indistinct; the tail of the male is bifid, that of the female simple and rounded.

The ova, agglutinated in long strings, are deposited in water, and being devoured by insects or Arachnida, undergo development within their bodies.

These animals frequently coil themselves into a knot-like form, whence the name.

See MERMIS.

BIBL. Dujardin, *Helminth.* p. 296, and *Ann. des Sc. Nat.* 1842. xviii. p. 142; Siebold, *Vergl. Anat.*; *Entomol. Zeitung*, 1842–43, and Erichson's *Archiv*, 1843. ii. p. 302; Berthold, *Ueb. d. Bau d. Wasserkalbes*, 1842; Meissner, *Siebold & Kölliker's Zeits.* 1856, i.; Siebold, *ibid.* 141; Grenacher, *Sieb. & Köll. Zeitsch.* 1868; Villot, *Ann. N. H.* 1872, x. p. 231.

GORGO'NIA, Linn.—A genus of marine Polypi, of the order Actinoida, and family Gorgoniadæ.

Char. Polypidom rooted, and consisting of a central, branched, horny, and sometimes

anastomosing flexible axis, coated with a soft and fleshy polypiferous crust.

The species are popularly known as sea-fans; they are not microscopic, often attaining very considerable dimensions.

The polypidom, as well as the crust, contains spicula of various forms imbedded in them, a specimen of which is exhibited in Pl. 33. fig. 27.

BIBL. Johnston, *Brit. Zooph.* p. 166; Kent (spicules), *M. M. J.* 1870, p. 76; Gosse, *Actinologia.*

GOSSYPIUM. See COTTON.

GOUT-STONES. See CHALK-STONES.

GRACIL'ARIA, Grev.—A genus of Rhodymeniaceæ (Florideous Algæ), with feathery fleshy-cartilaginous fronds, 3 to 12″ or more long, of a red or purplish colour, the central substance of which is composed of large cells, the cortical of closely packed horizontal filaments. The spores are formed in tubercles consisting of a thick coat composed of radiating filaments, containing a mass of minute spores on a central placenta. The tetraspores are imbedded in the cells of the surface. *G. confervoides* is the only common species; it grows from 3 to 20″ long, and as thick as small twine.

BIBL. Harvey, *Brit. Mar. Alg.* p. 128, pl. 16 C; *Engl. Bot.* pl. 1668.

GRAMMATONEMA, Ag.—A genus of microscopic marine plants, by some referred to the Diatomaceæ, by others, including Ralfs and Kützing, to the Desmidiaceæ.

The recent observations of Smith show that it belongs to the former family, and to the genus *Fragilaria.*

G. striatulum=*Fr. str.*

BIBL. Kützing, *Sp. Alg.* p. 187; Ralfs, *Ann. N. H.* xiii. p. 457, pl. 14. fig. 5; Smith, *Brit. Diat.* ii. 23.

GRAMMATOPH'ORA, Ehr.—A genus of Diatomaceæ.

Char. Frustules in front view rectangular, at first adnate, but afterwards forming zigzag chains; vittæ two, longitudinal, interrupted in the middle and more or less curved. Marine.

Valves linear or elliptical; furnished with transverse striæ, in most invisible by ordinary illumination, and in a few so difficult of detection that the valves have been regarded as TEST OBJECTS. Sometimes a median and terminal nodules are present.

Kützing describes thirteen species. Four are British; one doubtful:—

G. marina (Pl. 1. fig. 14; Pl. 12. fig. 35; Pl. 14. fig. 37). Striæ invisible by ordinary illumination; vittæ near the middle semicircularly curved outwards; valves linear or elliptical, gradually attenuated towards the obtuse ends; striæ transverse; length 1-108 to 1-420″.

The form and structure of the frustules and valves appear greatly to vary. Sometimes the frustules are perfectly square, at others six times as long as broad. In some specimens the valves are suddenly, at others uniformly inflated at the middle (Pl. 1. fig. 14 *b*; Pl. 12. fig. 35 *c*), some have the ends capitate. Again, in some valves there is a median line and a small central nodule (Pl. 12. fig. 35 *c*); in others there is neither median line nor nodule, but a large internal ring (Pl. 1. fig. 14 *b*). Lastly, in some valves the striæ extend over the whole of the valves, while in others they are deficient at their ends. Some of these variations have formed the basis of distinct species, but probably with little reason.

A variety, *G. subtilissima*, Bail. (Pl. 14. fig. 38 *a*, *b*), has been pointed out by Prof. Bailey, in which the form of the frustules and valves agrees with the above characters, but in which the transverse striæ are extremely difficult of detection when mounted in balsam.

G. macilenta. Fr. slender, often curved; vittæ as in the last; valves linear, slightly inflated at middle and ends. Marine; length 1-300″.

G. serpentina. Vittæ long, serpentine, with the end curved inwards to form a kind of hook; striæ oblique. Marine; length 1-200″.

G. ? Balfouriana. Vittæ straight; valves linear, inflated in the middle, and with rounded ends. Aquatic.

BIBL. Ehrenberg, *Berl. Abh.* 1839, p. 126, and *Ber.* 1840, &c.; Kützing, *Sp. Alg.* p. 120; Ralfs, *Ann. N. H.* 1844, xi. p. 449; Bailey, *Silliman's Journ.* vii.; Smith, *Brit. Diat.* ii. 42; Schiff, *Schultze's Archiv*, iii. p. 81.

GRAMMITID'EÆ.—A tribe of Polypodioid Ferns.

Illustrative Genera.

Grammitis. Sori linear or roundish, seated on certain arms of the veins. Veins simple or forked, scarcely anastomosing.

Selliguœa. Sori linear or roundish, seated on certain arms of the veins. Veins very much branched, anastomosing in more or less regular meshes, without free veins.

Synammia. Sori oblong, seated on the back of the lowest venule. Veins branched,

anastomosing into more or less regular meshes, with free venules.

Meniscium. Sori reniform, on the back of transverse venules. Veins pinnate, anastomosing.

Antrophyum. Sori imbedded on the back of all the veins and venules. Veins more or less branched, anastomosing in more or less regular meshes.

Hemionitis. Sori on the backs of all the veins and venules. Veins very much branched, anastomosing in more or less regular meshes.

Gymnogramma. Sori on the backs of all the veins and venules. Veins pinnate or forked, scarcely anastomosing.

GRAMMI'TIS, Swartz.—A genus of Grammitideæ; *Ceterach* is sometimes taken for a *Grammitis.*

GRAMMONE'MA, Ag. = Grammatonema.

GRAN'TIA, Fleming.—A genus of Sponges.

Char. Form variable; firmish and inelastic, usually white, with a close but porous texture, and composed of a gelatinous base, with imbedded calcareous spicula; orifices distinct. Marine.

Spicula simple, radiate or stellate, composed of carbonate of lime; hence easily distinguished from the siliceous spicula of other sponges by their dissolving with effervescence in a dilute acid. The organic basis is stated not to be fibrous as in most other sponges.

The seven British species are found growing upon or from rocks, sea-weeds, shellfish and zoophytes, between tide-marks. They vary in size from about the 1-10 to 3 or 4''. Gemmules have not been found.

Bibl. Johnston, *Brit. Sponges, &c.* p. 172; Grant, *Outl. of Compar. Anat.* and *Edin. New Phil. Journ.* i. and ii.; Bowerbank, *Brit. Spong.* ii. p. 1.

GRANULE-CELLS.—This term has been applied to cells found in animal solids and liquids containing a number of globules of fat or oil (Pl. 30. figs. 7, 16 *a*, 17 *e*). They are of variable size, perhaps the average may be placed at 1-2000''; and are easily recognized by the dark margins and light centres of the globules, which are insoluble in acetic acid and solution of potash. The cells sometimes contain a nucleus, at others not. The term granule-cells should properly be limited to cells of new formation, as those found in inflammation, cancer, &c.; but it has been so generally applied to cells of whatever kind, containing fatty globules, that it has no pathological signification.

See Degeneration, Fatty, and Inflammation.

GRANULOSE. See Starch.

GRAPE-FUNGUS. See Oidium.

GRAPHID'EÆ.—A family of Gymnocarpous or open-fruited Lichens, characterized by irregularly-formed, mostly elongated apothecia, with the margins closed in, or the disk covered with a veil, in the earliest state. The excipulum either special or formed by the thallus.

British Genera.

Opegrapha, Ach. *Thallus* crustaceous or membranous. *Apothecia* (*lirellæ*) elongated, simple, or branched, sessile; *excipulum* carbonaceous, entire or surrounding the sides and base. The *disk* chink-like or channelled, with a proper border.

Graphis, Ach. *Thallus* crustaceous or membranous. *Apothecia* lirelliform, immersed; *excipulum* carbonaceous, halved or confined to the side, the base being naked; *disk* channelled, surrounded by a proper border and an accessory one from the thallus.

Hymenodecton, Leighton. *Thallus* crustaceous or membranous. *Apothecia* lirelliform, immersed; *excipulum* a very thin, black, cartilaginous membrane, entire or surrounding the sides and base; *disk* broad, plane, smooth, surrounded by a very slender proper border and an accessory one derived from the thallus.

Chiographa, Leight. *Thallus* membranaceous. *Apothecia* lirelliform or subdiscoid, sessile; *excipulum* carbonaceous, entire or surrounding the sides and base; *disk* plane, broad, surrounded by a proper border and an accessory one derived from the thallus.

Aulacographa, Leight. *Thallus* membranaceous. *Apothecia* lirelliform, subimmersed, prominent; *excipulum* carbonaceous, halved or confined to the sides, palmatifid, the base naked; *disk* chink-like, closed, surrounded by a proper longitudinally-furrowed border, and an accessory one derived from the thallus.

Lecanactis, Eschweiler. *Thallus* crustaceous. *Apothecia* lirelliform or subdiscoid, immersed; *excipulum* carbonaceous, entire or surrounding the sides and base; *disk* plane, open, pruinose, surrounded by a proper border.

Platygramma, Leight. *Thallus* crustaceous. *Apothecia* lirelliform, almost simple or radiate; *excipulum* none; sporiferous

layer free; *disk* plane, open, naked, without any margin.

Arthonia, Ach. *Thallus* cartilagineo-membranous. *Apothecia* roundish or deformed, tumid, innately sessile, covered with a subcartilaginous membrane, subgelatinous within, containing immediately under the surface a series of pear-shaped thecæ; no *excipulum*; *disk* nearly plane, without a border, black and rough.

Coniocarpon, D.C. *Thallus* crustaceous. *Apothecia* appressed, roundish-deformed or elongated, covered with a subcartilaginous membrane, which ultimately breaks up into a fine powder, subgelatinous within, containing a series of pear-shaped thecæ; no *perithecium*; *disk* flat, depressed, without a border, pruinose.

Bibl. Leighton, *Brit. Lichen-Flora*, p. 360.

GRA'PHIS, Ach.—A genus of Graphideæ (Gymnocarpous Lichens), containing several British species very variable in their appearance; mostly whitish or yellow papery expansions on bark, beset with irregular black markings like writing.

Bibl. Leighton, *Brit. Lich.-Fl.* p. 362.

GRASSES.—A family of Monocotyledonous Flowering Plants remarkable in many respects for their microscopic structure, especially the siliceous Epidermis and the Starch grains in the Albumen, for which see those heads.

GRATELOU'PIA, Ag.—A genus of Cryptonemiaceæ (Florideous Algæ), represented by a very rare British species, *G. filicina*, rarely growing more than 2 inches high with us. Fructification minute, immersed, favellidia opening by a pore, and cruciate, tetraspores vertically placed among the filaments of the periphery.

Bibl. Harv. *Brit. Mar. Alg.* p. 137, pl. 17A; Grev. *Alg. Brit.* pl. 16.

GREENSAND.—According to the observations of Ehrenberg and Bailey, the glauconitic grains frequent in many geological deposits, and constituting certain beds known as Greensand, are formed of fossilized organic bodies, mostly casts of Foraminifera.

Bibl. Ehrenberg, *Abhandl. Berl. Akad.* 1856, 85–176; *Monatsber.* 1858, 328; Bailey, *Ann. N. H.* s. 2. xviii. 425; Parker & Jones, *Ann. N. H.* s. 4. x. 263.

GREGARI'NA, Dufour.—The curious organisms of which this genus consists, are placed provisionally among the Entozoa; they have as yet been insufficiently examined, and authors are not agreed as to their structure and nature.

They exist as parasites within the bodies of animals, and inhabit the intestinal canal, or the cavity of the abdomen. Most frequently they are met with in insects, especially their larvæ; but sometimes also in Annelida, both aquatic and marine (*Lumbricus* &c.), in the Crustacea and Mollusca.

They are microscopic and colourless; mostly round, oval, fusiform, or cylindrical (Pl. 16. figs. 25, 28, 34); and consist of a smooth transparent cell-wall, enclosing a granular, more or less liquid mass, with one or more nuclei and nucleoli. Sometimes they exhibit a constriction in the middle, or are divided by a transverse septum. In some a process resembling a head is situated at one end; this may be short, round, and obtuse or pointed, or more elongated and furnished with reflexed hook-like processes. The *Gregarinæ* are capable of motion, which is either that of slow progression, ensuing without contraction of the body, or produced by irregular contraction of the membrane or substance of the body.

Vibratile cilia have been detected both upon the outer and the inner surface of the membrane; and the internal granules often exhibit molecular motion, especially after the addition of water. One or more long motionless filaments sometimes arise from the outer surface.

The membrane and its contents, except the nucleus, are soluble in acetic acid.

Their method of propagation, if such it is, represents a form of conjugation, and takes place as follows. Two individuals coming into contact by corresponding portions of the body (Pl. 16. fig. 34), become shortened and firmly united. A transparent capsule is next formed around the two individuals, which encloses them in a cyst (figs. 26, 30), the adjacent portions of the cell-membranes are absorbed, and the substance of the two bodies becomes intimately fused. Globules or cells are then formed in the contents of the cell, which subsequently assume the form of *Naviculæ*, and have been called pseudo-naviculæ (erroneously *navicellæ*) (figs. 31, 32, 33); these are supposed to represent the germs of new *Gregarinæ*, which become liberated by the bursting of the cell.

It has been supposed that the pseudo-naviculæ might really represent *Naviculæ*, and that the cysts containing them were sporangia; but this view does not appear

probable, neither do the pseudo-naviculæ possess a coat of silex.

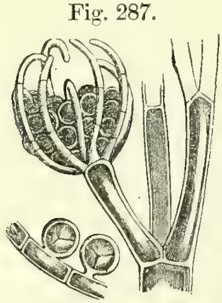
In some cases it appears that the contents of the two cells in conjugation remain distinct until the pseudo-naviculæ are formed; but it is not certain whether each single cell in these instances has not arisen from the fusion of two others.

A very large number, more than eighty species, of *Gregarina* have been described and arranged in numerous genera.

Bibl. Dufour, *Ann. d. Sc. Nat.* 1837, vii.; Stein, *Müller's Arch.* 1848; *Ann. N. H.* 1850, v., and *Infus.*; Frantzius, *Observat. de Gregar.* 1846; Henle, *Müller's Archiv*, 1835, 1845; Siebold, *Beitr. z. Naturg. d. wirbellos. Thiere*, 1839; Kölliker, *Siebold und Kölliker's Zeitschr.* 1848 & 1849; Ray Lankester, *Qu. Mic. Jn.* 1863, p. 83, and *Mic. Tr.* 1866, p. 23 (Pl.); V. Beneden (*G.* of lobster), *Bull. d. l'Acad. d. la Belgique*, 1869 (*M. M. J.* 1870, p. 47), and *Ann. N. Hist.* 1872, x. p. 309.

GRIFFITH'SIA, Ag.—A genus of Ceramiaceæ (Florideous Algæ), with feathery fronds 3 to 6″ long, composed of delicate dichotomously-branched filaments consisting of a single row of cells, the branchlets often whorled; colour crimson or rosy-red. The fructification consists of *spores*, *antheridia*, and *tetraspores*, all produced in similar situations, namely at the articulations, where they are surrounded by a kind of involucre formed of short ramelli, to which the tetraspores and antheridia are attached. The antheridia consist of a kind of shrubby tuft of extremely minute filaments arising

Fig. 287.



Griffithsia sphærica.

Fig. 287. Fragment of a frond bearing an involucre with tetraspores. Magn. 20 diams.

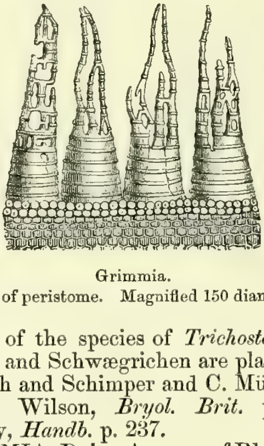
Detached ramellus of the involucre, showing the attachment of the tetraspores. Magn. 40 diams.

from an axial filament which arises from a ramellus of the involucre. Fig. 287 represents a branch terminating in an involucre of whorled ramelli bearing tetraspores; the lower figure is a portion of a ramellus, showing the mode of attachment of the tetraspores. In the antheridial involucres, the plumose antheridial structure is attached in exactly the same way. Seven British species are recorded, of which one or two are not uncommon.

Bibl. Harvey, *Brit. Mar. Alg.* p. 167, pl. 23 B; Decaisne, *Ann. d. Sc. Nat.* 2 sér. xvii. p. 353, pl. 16; Thuret, *Ann. des Sc. Nat.* 3rd sér. xvi. p. 16, pl. 5; Derbès and Solier, *ibid.* xiv. p. 276, pl. 36; *Engl. Bot.* pl. 1479 & 1689.

GRIM'MIA, Ehrhart.—A genus of Orthotrichaceous Mosses, containing numerous British species.

Fig. 288.



Grimmia.

Teeth of peristome. Magnified 150 diameters.

Many of the species of *Trichostomum* of Hedwig and Schwægrichen are placed here by Bruch and Schimper and C. Müller.

Bibl. Wilson, *Bryol. Brit.* p. 152; Berkeley, *Handb.* p. 237.

GRO'MIA, Duj.—A genus of Rhizopoda, of the order Reticularia.

Char. Carapace brownish yellow, membranous, soft, globular or oval, with a small round orifice, from which very long, filiform, branched expansions with very delicate extremities protrude.

G. oviformis. Carapace globular, with a short neck; marine; size 1-25 to 1-12″. Found among marine plants.

G. fluviatilis (Pl. 24. fig. 15). Carapace globular or ovoid, without a neck; aquatic; breadth 1-280 to 1-100″. Found upon *Ceratophyllum.*

Schlumberger describes an aquatic *Gromia* (*hyalina*), differing from the last in size (1-860 to 1-520″), and in the carapace being colourless, hence it probably represents the

young state of *G. fluviatilis*. Schultze describes two new marine species: *G. oviformis* and *G. Dujardinii*.

BIBL. Dujardin, *Ann. d. Sc. Nat.* 1835, iv. *Infus.* p. 252; Schlumberger, *Ann. d. Sc. Nat.* 1845, iii. p. 255; Schultze, *Polythal.* p. 55.

GROWING-SLIDE.—Several modifications of this apparatus (*Introd.* p. xx) have been recently described.

See Smith, *Ann. N. H.* 1865, xvii. 334; Barker, *Qu. M. Jn.* 1866, p. 267; R. Beck, *Mic. Tr.* 1866, p. 34; Müller, *M. M. Jn.* i. 1869, p. 174; Maddox, *M. M. Jn.* 1870, iii. p. 14.

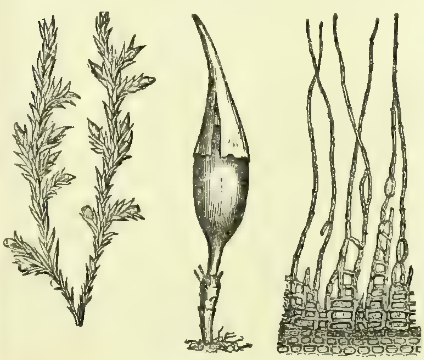
GUANO.—As is well known, guano is imported into this country in large quantities as a manure. It consists principally of the excrement of birds, in a more or less decomposed state. It affords the microscopist a means of procuring the foreign marine Diatomaceæ, the frustules and valves of which are often contained in it in large numbers. The Diatomaceæ may be obtained from guano as recommended at page 239.

GUEMBE'LIA, Hmp.—A genus of Orthotrichaceous Mosses, including various species, separated from *Grimmia* on account of the peculiar calyptra, and also the *Cinclidoti* of P. Beauvais.

G. orbicularis, Hmpe. = *Grimmia orbicularis*, Br. Eur.

G. riparia = *Cinclidotus riparia*, Wils.

Fig. 289. Fig. 290. Fig. 291.



Guembelia fontinaloides.

Fig. 289. A fertile shoot.
Fig. 290. Capsule with calyptra. Magn. 10 diams.
Fig. 291. Teeth from the peristome. Magn. 150 diams.

G. fontinaloides (figs. 289–91) = *Cincl. fontinaloides*, P. B.

BIBL. Wilson, *Bryol. Brit.* p. 139.

GUM.—A name applied to various viscid (not oily) secretions of plants. Gums have no microscopic structure when pure and clean, but often exhibit under the microscope traces of structures, such as debris of cellular tissue, filamentous Fungi, &c., which have become imbedded in them while soft. What is called gum TRAGACANTH consists of partly decomposed cell-membranes, in a condition allied to amyloid, retaining traces of their organization. Sections of very soft tissues or very minute objects may be made by imbuing them with or immersing them in solution of gum, and allowing the whole to dry up to a tough, semisolid mass, capable of being sliced with a razor. The slices are freed from gum by soaking in water. Gum dissolved in GLYCERINE forms an excellent medium for mounting vegetable tissues.

GUTTA-PERCHA.—A kind of gum-resin produced by the evaporation of the milky juice of the *Isonandra gutta*, one of the family of the Sapotaceæ, a native of Sumatra and the neighbouring regions. Its relation to the microscope arises from its use in a solid form and as cement, in mounting microscopic objects in cells. See CEMENTS and PREPARATION.

GUTTULINA. See POLYMORPHINA.

GY'GES, Bory.—Described by Ehrenberg as a genus of Volvocineæ, having neither eye-spot, tail, nor flagelliform filament; the carapace (cell-membrane) simple, subglobose.

Motion very slow. He gives two species:

G. granulum (Pl. 41. fig. 14). Ovate or subglobose; internal granular mass dark green; diam. 1-1150''. Aquatic.

G. bipartitus. Nearly spherical; internal mass yellowish green, frequently bipartite; diam. 1-480''. Aquatic.

So far as appears from the descriptions and figures, these do not seem to differ from PROTOCOCCUS.

(For *G. sanguineus*, Shuttleworth, see RED SNOW.)

BIBL. Ehr. *Infus.* p. 51.

GYMNOGON'GRUS, Mart.—A genus of Cryptonemiaceæ (Florideous Algæ), with horny branched fronds, the divisions cylindrical or compressed, a few inches high, of a purplish-red colour. The substance of the branches presents three layers of closely packed filamentous cells, the central longitudinal, the intermediate curved, and the peripherical horizontal and moniliform.

The spores have not been observed; the tetraspores (cruciate) are arranged in moniliform rows, in wart-like thickenings of the branches.

BIBL. Harvey, *Brit. Mar. Alg.* p. 145, pl. 18 B; *Engl. Bot.* pl. 1089 & 1926.

GYMNOGRAM'MA, Desv.—A genus of Grammitideæ (Polypodioid Ferns), some of the species of which are remarkable for a yellow or white pulverulent appearance on the back of the fronds, owing to the presence of abundance of microscopic cellular hairs, ex. gr. *G. Calomelanos, G. chrysophylla, ochracea*, &c.

GYMNOMIT'RIUM, Corda.—A genus of Jungermannieæ (Hepaticæ), containing one British alpine species, the *Jungermannia concinnata* of the British Flora.

BIBL. Hook. *Brit. Jungerm.* pl. 3; Ekart, *Synops. Jungerm.* pl. 8. fig. 63; *Engl. Bot.* pl. 1022.

GYMNOSPER'MIA.—A division of the Flowering Plants (see VEGETABLE KINGDOM), including the CONIFERÆ and CYCADACEÆ; deriving this name from the mode of development of the OVULES.

GYMNOSPORAN'GIUM, D.C.—A genus of Uredinei (Coniomycetous Fungi). *G. juniperinum* grows upon living branches of the common Juniper, appearing at first like an exanthema on the bark, which in wet weather swells up into an orange-coloured, tremelloid plicate mass, which readily dries up, however, and then is scarcely visible. Somewhat rare, but when present generally copious.

BIBL. Berk. *Brit. Flora*, vi. part 2. p. 361; Fries, *Syst. Myc.* iii. p. 505; Tulasne, *Ann. des Sc. Nat.* 4 sér. ii. pp. 171 & 188.

GYMNOSPO'RIUM, Corda.—A genus of Torulacei (Coniomycetous Fungi), characterized by an obscure mycelium and unicellular black spores arising apparently from the matrix. It is the lowest condition of which Torulacei are capable.

G. arundinis occurs in this country on reeds.

BIBL. Corda, *Anleitung*, p. 10; Berk. *Out.* p. 328.

GYMNOS'TOMUM, Schwägr.—A genus of Mosses, now distributed into PYRAMIDIUM, PHYSCOMITRIUM, and other genera.

BIBL. Müller, *Syn. Musc.*; Bruch and Schimper, *Bryol. Eur.*; Wilson, *Bryol. Brit.* p. 39; Berkeley, *Handb.* p. 237.

GYRI'NUS, Geoffr.—A genus of Coleopterous insects, of the family Gyrinidæ.

G. natator, one of the eight British species of this genus, is very commonly seen in groups performing its gyrations upon the surface of pools or rivers, whence it has received the popular name of whirligig.

The body is ovate, or elliptic and depressed, the elytra black and shining. The antennæ are short and retractile within a cavity in front of the eyes; the basal joint minute; the second large, globular, and furnished externally with an ear-like joint fringed with colourless, flattened, hair-like processes; the remaining seven joints form a clavate mass, being very short and closely united, the first commencing by a very narrow base or pedicle. The eyes are divided by a transverse septum into two parts, the upper of which serves for viewing objects in the air, the latter those in water; by some authors these insects are described as possessing four distinct eyes. The terminal segment of the abdomen is furnished with two retractile ciliated lobes. The two fore legs are long, and of the ordinary form, whilst the four hind legs (Pl. 27. fig. 5), which are used as oars, are short, flat, and dilated; the femur (*d*) and tibia (*c*) somewhat triangular, the tibia also fringed with short spines and long flattened filaments; in the middle pair of legs the latter exist on both margins, whilst in the hind legs these are present only on the outer margin. The tarsi (*a*) are five-jointed, the three basal joints produced on the inside into long, flat, leaf-like lobes fringed with spines; the fourth joint is of about the same size, and semicircular, the fifth being very short and attached to the fourth near the end, and both are fringed on their outer margin with flattened filaments resembling those upon the tibia; all the tarsi are furnished with two distinct claws.

The anterior tarsi of the male differ from those of the female, as in *Dytiscus*. The circulating currents can be seen in the hind legs.

The larva (Pl. 28. fig. 19), which is aquatic, is of a dirty-white colour, long, narrow, and depressed, resembling a small centipede; it consists of thirteen segments including the head. Its antennæ are filiform and four-jointed; the eyes numerous and tubercular, grouped on each side of the head. The three pairs of legs are attached to the eight anterior segments of the body; the remaining segments are furnished on each side with a branchial filament, excepting the last, which has two of them, and four mi-

nute conical points, bent downwards, and used by the insect when in motion.

Bibl. Westwood, *Introd. &c.* i. p. 105; Stephens, *Brit. Coleop.* p. 78.

GYRODAC'TYLUS, Nordm.—A genus of Trematode Entozoa.

G. auriculatus (Pl. 16. fig. 7) is often found adhering to the gills of fishes, as the carp, stickleback, &c.

Bibl. Dujardin, *Helminth.* p. 480; Wagener, *Qu. M. Jn.* 1861, p. 196; Cobbold, *Qu. M. Jn.* 1862, p. 35.

GYROPH'ORA, Ach. — A genus of Pyxinieæ (Gymnocarpous Lichens), combined with *Umbilicaria* by many authors.

GYROPOREL'LA, Gümbel.—A small cylindrical Foraminifer, belonging to the *Dactyloporida*, and consisting of ring-like segments traversed by simple canals. Its several species constitute large masses of Triassic limestone in the Alps.

Bibl. Gümbel, *Abhandl. München*, xi. 268.

GYR'OPUS, Nitzsch.—A genus of mandibulate Anoplura (Insects), of the family Liotheidæ.

Char. Tarsi two-jointed, with a single claw.

Mandibles without teeth; maxillary palpi conical and four-jointed; labial palpi none; antennæ four-jointed; thorax two-jointed; abdomen ten-jointed.

G. ovalis (Pl. 28. fig. 8). Head ferruginous, transverse, with a lateral produced lobe on each side; thorax and legs ferruginous; abdomen nearly orbicular, yellowish white; claws long, curved, and strong; length 1-48''.

Found upon the guineapig (*Cavia cobaya*).

G. gracilis. Head and thorax ferruginous; abdomen elongate, segments with a transverse striated band at each suture; claws very short and minute; length 1-36''.

Found also upon the guineapig.

Bibl. Denny, *Anoplur. Monogr.*

GYROSIG'MA, Hass. (*Pleurosigma*, Sm.). —A genus of Diatomaceæ.

Char. Frustules single, free, longer than broad; front view linear or linear-lanceolate; valves navicular, sigmoid, with a longitudinal line, and a nodule in the centre and at each end.

The group of species arranged in this genus should properly form a subgenus of *Navicula*, inasmuch as the sigmoid form of the valves, upon which the distinguishing character is founded, does not exist in all the species of *Gyrosigma* to a greater extent than that in which it occurs in some species of *Navicula*; in some, its only indication is a slight inequality in the two halves of the valves. The median line and nodules consist of an internal thickening of the valves at the corresponding parts; the line is best seen in the front view (Pl. 11. fig. 16); it is occasionally found in a fractured valve, projecting as a solid highly refractive rod, the thinner adjacent portions of the valve being broken away; for brevity, it may be called the keel.

The valves exhibit spurious striæ, arising from the existence of rows of dots, of which we have already treated under Diatomaceæ. These striæ and dots are in most species very difficult to detect, requiring the use of oblique light, and the modern condensers with the stops; the principles which should guide in the search for them have been explained under Angular aperture; the preliminary preparation of the valves is also essential (Diatomaceæ, p. 239).

Most of the species are found in salt or brackish water; a few are aquatic. They often abound upon the surface of mud. Conjugation or the formation of sporangia has not been observed. The frustules are sometimes found enveloped in amorphous mucus, and those of one species have been found within gelatinous tubes.

Many species have been described, of which those that have been used as Test-objects will be enumerated. We must, however, express our belief that they cannot truly be regarded as distinct species,—unless of microscopic objects, if the term may be permitted. The measurements are mostly those of the Rev. Mr. Smith and Mr. R. Beck, with which our own have coincided very nearly. The species are arranged according to the fineness of the markings, which coincides with the difficulty with which they are detected and resolved into dots; and the appended figures express the number of striæ or rows of dots in 1-1000''.

Striæ oblique (dots alternate or quincuncial, Pl. 11. fig. 40).

G. formosum (Pl. 11. fig. 25). Broadly linear, attenuated towards the ends; sigmoidure evident; keel oblique; length 1-60''; striæ 36. Marine.

G. decorum (Pl. 11. fig. 26). Rhomboid-linear; attenuated; sigmoidure very evi-

dent; keel oblique; length 1-90″; striæ 36. Marine.

G. speciosum (fig. 28). Linear-lanceolate; sigmoidure resulting from the curvature of one margin of each half of the valve, the opposite margin of each respective half being nearly straight; keel in each half forming two curves; very oblique near the end; length 1-90″; marine; striæ 44. The halves of the valves somewhat resemble the blade of a pocket-knife.

G. strigosum (fig. 29). Linear-lanceolate; ends rather obtuse, sigmoidure slight; keel nearly straight in the middle, curved near the ends; length 1-90″; striæ 45. Marine. Fig. 40 represents the striæ resolved into dots.

G. quadratum (fig. 34). Rhomboidal, acuminate at the ends; sigmoidure evident towards the ends; keel curved, nearly median; length 1-150″; marine; striæ 45.

G. elongatum (Pl. 11. fig. 31, and Pl. 1. fig. 18). Linear-lanceolate, acuminate; sigmoidure slight, uniform; keel median; length 1-80″; marine; striæ 48.

G. rigidum (fig. 30). Linear-lanceolate, obtuse at the ends; sigmoidure slight; keel nearly median; length 1-70″; marine; striæ 48.

G. angulatum (*Navicula angulata*) (Pl. 11. fig. 33). Rhomboid-lanceolate or angular-lanceolate; sigmoidure evident; keel nearly median; length 1-110″; marine; striæ 52. Pl. 1. fig. 16 represents a valve with the striæ resolved into dots; Pl. 11. fig. 41 represents the dots very highly magnified; and Pl. 11. fig. 46 exhibits the appearance of hemispherules, which some authors consider to form the true structure.

Pl. 11. fig. 33 *a* represents a specimen with the endochrome and nucleus.

β (fig. 33 *b*). Simply and narrowly lanceolate, ends acute.

γ (fig. 33 *c*). Ends beaked; abruptly flexed.

G. æstuarii (fig. 35). Lanceolate; ends abruptly tapering, short and beak-like; sigmoidure evident; keel not median; length 1-250″; marine; striæ 54.

G. intermedium (fig. 36). Narrowly linear-lanceolate, acute; sigmoidure none, or merely indicated by a slight inequality in the opposite margins of the valves; keel nearly straight and almost median; length 1-140″; marine; striæ 55.

β *G. nubecula*. Ends obtuse; slightly more lanceolate, and shorter; marine; striæ 55.

G. delicatulum (fig. 32). Very narrowly near-lanceolate; sigmoidure evident; keel nearly central; marine; length 1-130″; striæ 64.

G. obscurum (fig. 27). Linear, attenuated near the ends; sigmoidure slight; principally arising from the curvature of one margin of each half of the valve; keel not median, especially near the ends; marine; length 1-200″; striæ 75.

Striæ longitudinal and transverse (dots opposite, Pl. 11. figs. 39, 42).

In most of the following species or forms the dots are not equidistant in the longitudinal and transverse rows.

G. strigilis (fig. 12). Linear-lanceolate; sigmoidure evident; keel nearly median, flexure double; marine; length 1-75″; striæ: longitudinal 40, transverse 36.

G. balticum (fig. 10). Broadly linear, narrowed at the ends; sigmoidure apparent at the ends only, and produced principally by the curvature of one margin only; keel not median, flexure double; marine; length 1-80″; striæ, both sets, 38. Fig. 39, piece of valve, showing dots.

β. Gradually tapering towards the ends; striæ obscure.

G. Hippocampus (fig. 13). Narrowly lanceolate, gradually attenuated towards the broad, very obtuse ends; sigmoidure evident; keel nearly median; marine or brackish water; length 1-160″; striæ: long. 32, tr. 40.

G. attenuatum (fig. 15. Pl. 1. fig. 17). Linear-lanceolate, with obtuse ends; sigmoidure slight; keel nearly median; marine and aquatic; length 1-120″; striæ: long. 30, tr. 40.

G. lacustre (fig. 18). Linear-lanceolate, ends rather obtuse; sigmoidure evident; keel almost median; aquatic; length 1-130″; striæ, both sets, 48.

G. tenuissimum (fig. 24). Narrowly linear, attenuate towards the ends; sigmoidure evident; keel nearly central; aquatic; length 1-180″; striæ, both sets, 48.

G. Spencerii (fig. 17). Linear-lanceolate; sigmoidure evident; keel nearly median; aquatic; length 1-200″; striæ: long. 55, tr. 50.

G. littorale (fig. 19). Lanceolate, ends somewhat prolonged; sigmoidure evident; keel median; aquatic; length 1-180″; striæ: long. 24, tr. 50. Fig. 42 represents the dots upon part of a valve.

G. acuminatum (fig. 14). Linear-lanceolate, acuminate; sigmoidure evident;

keel median; aquatic; length 1-150″; striæ: long. 40, tr. 52.

G. fasciola (fig. 21). Linear-lanceolate; with linear beak-like ends; sigmoidure evident; marine; length 1-200″; striæ: long. (?), tr. 64.

G. prolongatum (fig. 23). Very narrowly linear-lanceolate, acuminate, with linear beak-like ends; sigmoidure present in the ends only; keel nearly median; marine; length 1-200″; striæ: long. (?), tr. 65.

G. distortum (fig. 20). Lanceolate; ends slightly produced and beak-like; sigmoidure evident; keel central; marine; length 1-300″; striæ: long. 65, tr. 75.

G. macrum (fig. 22). Very narrowly linear-lanceolate; ends produced into long beak-like processes; sigmoidure produced by the ends of the beaks only; keel median; length 1-100″; striæ: long. (?), tr. 85.

Bibl. Hassall, *Freshwater Algæ*, p. 435; Smith, *Brit. Diatom.* i. p. 61; Kützing, *Sp. Alg. and Bacill.*; Rabenhorst, *Fl. Alg.* i. p. 230 (46 European species).

H.

HÆ'MATINE.—The red colouring-matter of the blood, in the globules of which it exists combined with globuline. It possesses no morphological characters.

Bibl. See Chemistry.

HÆMATOCOC'CUS. See Protococcus and Glœocapsa.

HÆMATO'IDINE.—This substance, to which Virchow first drew attention, is not unfrequently met with in masses of extravasated blood which have remained for some time in the living bodies of the Vertebrata, as in old apoplectic clots, sanguineous extravasations resulting from contusions and wounds, the effusions accompanying the rupture of the Graafian vesicles, &c.

It occurs in the form of granules, globules, and distinct crystals. These are somewhat highly refractive, and mostly of a ruby-red or yellowish-red colour; they are stated also to have been found colourless. The most common forms are represented in Pl. 9. fig. 16, and they appear to belong to two distinct systems—the oblique rhombic prismatic, and the regular system.

The properties of hæmatoidine are as inconstant as the crystalline form; and it is probable that several different substances have been ranged under the above title, or perhaps modifications of the same substance in different states of hydration; for so insuperable has been the difficulty of obtaining hæmatoidine in quantity and a state of purity, that its true nature has not been satisfactorily determined.

It is mostly insoluble or difficultly soluble in water, alcohol, ether, acetic and dilute mineral acids, and solution of potash. Sometimes it is soluble in acetic acid, with a yellow colour, at others readily so in water.

An amorphous colourless proteine-substance is sometimes separated from the crystals by the action of mineral acids.

Modern researches seem to show that the hæmatoidine or blood-crystals consist sometimes of hæmatine, at others of hæmatoglobuline (hæmoglobine); but the relations of these matters are still obscure.

Hæmatoidine may be artificially procured from various sources, perhaps most readily from the blood of fishes by spontaneous evaporation. The blood of the spleen of the horse changes almost entirely into prismatic crystals of it in drying. In obtaining the crystals, the presence of the serum is prejudicial, and it should be washed away with a small quantity of water. If recently dried blood be treated with a vegetable acid (acetic, oxalic acid, &c.), and a drop of the solution be placed upon a slide, covered with thin glass, and kept at a temperature of 80° to 100° F., the crystals may also be obtained. This reaction might be of use in judicial investigations. The addition of water and a little alcohol or ether to the blood, sometimes favours the separation of the crystals.

Crystals of hæmatoidine have been found within the blood-globules prior to the addition of reagents.

Their preservation is difficult; it is best effected by washing them with alcohol, or this liquid somewhat diluted with water, and drying them under the air-pump, or over sulphuric acid.

Bibl. Virchow, *Ann. d. Chem. u. Pharm.* 1851 (*Chem. Gaz.* 1852); Funke, *Zeitsch. f. rat. Med.* 1851, i. p. 172, 1852, ii. pp. 199 & 288; Kunde, *ibid.* 1852, ii. p. 271; Lehmann, *Gmelin's Handbuch*, viii.; Sanderson, *Edinb. Month. Jn.* xiii. pp. 216, 521; Kölliker, *Mikrosk. Anat.*; Teichmann, *Zeits. f. rat. Med.* 1853, iii. p. 375; Frey, *Histologie &c.*, 1870; Freyer, *Blut-Krystalle.*

HÆMATOPI'NUS, Leach.—A genus of Insects, of the order Anoplura, and family Pediculidæ.

Char. Legs all formed for climbing; thorax generally narrower than the abdomen, and distinctly separated from it; abdomen composed of eight or nine segments.

This genus contains several species, which live as parasites upon various animals—the field-mouse, rat, dog, ox, horse, ass, calf, hog, rabbit, hare, squirrel, &c.

H. suis (Pl. 28. fig. 4; fig. 4*, anterior leg). Dusky ferruginous; abdomen grey or ashy-yellow, flat and membranaceous, with a black horny excrescence surrounding each of the white spiracles; legs long and thick; femur transversely striped; tibia very abruptly clavate, dark-coloured at the end; tarsi with a large fleshy pulvillus.

Found upon pigs out of condition; length 1-10 to 1-6″.

BIBL. Denny, *Monogr. Anopl. Brit.* p. 24; Gervais, *Walckenaer's Aptères*, iii. 301.

HÆMATOPO'TA, Meig.—A genus of Dipterous Insects, of the family Tabanidæ.

Distinguished by the six-jointed antennæ, which are longer than the head, with the third joint thickened at the base.

H. pluvialis, of which most persons must have experienced the pungent bite in or near woods in warm weather, is interesting on account of the great development of the lancets, and the beautiful iridescence of the eyes.

BIBL. See TABANIDÆ.

HÆMO'CHARIS, Sav. (*Piscicola*, Blainv.).—A genus of Annulata.

H. piscium (*Piscicola geometra*) is a leech-like animal, found upon the carp, tench, roach, &c. Length 1 to 2″.

BIBL. Leo, *Müller's Archiv*, 1835; Leydig, *Siebold und Kölliker's Zeitschr.* i.; Brightwell, *Ann. N. H.* 1842, ix. 11.

HÆ'MOPIS, Sav.—A genus of Annulata.

H. sanguisorba, the common horse-leech. In this animal the teeth are less numerous and more obtuse than in the medicinal leech (*Hirudo officinalis*).

HAIL.—The microscopic structure of hail-stones does not appear to be uniform. In some a central nucleus surrounded by concentric layers has been noticed; in others the nucleus is enveloped by a radiating crystalline crust; or, again, the entire mass has been found to consist of little spheres of ice. When hail-stones liquefy, a copious evolution of gas takes place. Hail-stones may best be collected for examination in a blanket, which being a bad conductor of heat, retains them longest in the solid state. Connected with the structure and formation of hail-stones, is the composition of spherules of condensed vapour. These are generally believed to consist of films of water enclosing portions of air; but Dr. Waller's observations have led him to the conclusion that they are simply composed of water. If the former view were correct, those hail-stones which consist of aggregations of icy spherules, should contain air within them, which does not appear to be the case; but in deciding this question, attention must be paid to the principles laid down in the INTRODUCTION, p. xxxiii, *f.*, which will afford a simple means of deciding the point.

In some liquefied hail-stones, the spores of fungi and algæ, with infusoria, have been found.

BIBL. Pouillet, *Elém. d. Physique,* ii.; Waller, *Phil. Tr.* 1847, p. 23; id. *Phil. Mag.* 1846, xxix. p. 103, and 1847, xxx. p. 159; Harting, *Skiz. aus d. Natur.*

HAIR OF ANIMALS.—The structure of the hair of animals is very complicated, and requires careful manipulation for its investigation. We shall commence with the hair of man, in which it has been the most perfectly examined.

Human hair. When a hair is viewed under a low power, it appears black at the sides and light in the middle, so as to convey a notion of its being a tube; such is not, however, the case, although this notion was long admitted.

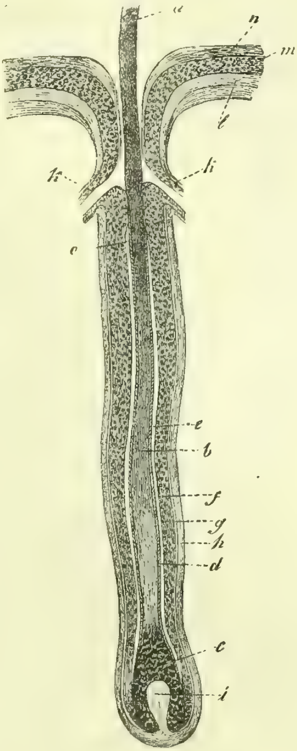
The hairs are secreted by the skin, and consist of modified epidermic formations. Each is implanted in a cutaneous depression, termed the hair-follicle (fig. 292), at the bottom of which it is fixed by a dilatation called the knob or bulb of the hair (*c*). The free portion, or that projecting beyond the skin, is the shaft or scape (*a*); and that above the bulb but contained within the follicle, is the root (*b*). The bulb encloses or surrounds a conical or rounded body (*i*), the papilla or pulp.

Three varieties of hair are met with upon different parts of the body: 1, consisting of long, soft hairs, from 1 to 3″ and more in length, as the hair of the head; 2, short, rigid and thicker hairs, from 1-4 to 1-2″ in length, as in the eye-lashes; and 3, short, very slender hairs, from 1-12 to 1-6″ in length, as in the down or woolly hairs of the face, the back and extremities.

When the shaft of a hair is examined under the microscope by transmitted light, two structures are mostly distinguishable,

a median, more or less black, somewhat irregularly granular and linear portion—the medulla or pith; and an outer, fibrous-looking portion, mostly more or less co-

Fig. 292.



Magnified 50 diameters.

A hair of moderate size, contained in its follicle. *a*, shaft; *b*, root; *c*, bulb or knob; *d*, cuticle of the hair; *e*, inner sheath of the root; *f*, outer sheath of the root; *g*, structureless membrane of the hair-follicle; *h*, transverse- and longitudinal-fibrous layer of the same; *i*, papilla; *k*, excretory ducts of the sebaceous glands or follicles, with their epithelial and fibrous layer; *l*, cutis of the orifice of the hair-follicle; *m*, rete mucosum; *n*, cutaneous epidermis; *o*, termination of the inner sheath of the root.

loured according to the colour of the hair—the cortex, cortical or fibrous portion.

The *cortical portion* is that upon which the firmness, elasticity, and colour of the hair depends, and constitutes the greater portion of its bulk. It exhibits numerous longitudinal striæ, or interrupted dark lines and dots. When acted upon by strong sulphuric or some other acid at a gentle heat, it becomes at first resolved into plates or fibres (fig. 293 *B*) of the most varied sizes, both as to length and breadth; but if the action of the acid be continued, these fibres become separated into cells (fig. 293 *A*).

Fig. 293.

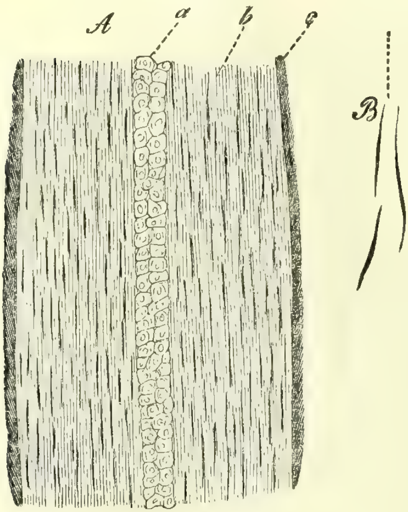
Magnified 350 diameters.

Plates and cells of the cortical substance of a hair, after treatment with acetic acid. *A*, separate cells. 1, front view (three of them isolated, two united); 2, side view. *B*, a layer, composed of several cells.

These cells present uneven surfaces, and a more or less elliptical outline, their true form being spindle-shaped; but they are mostly flattened and angular, or curved from mutual pressure, resulting from their aggregation into the shaft of the hair. The cells are about 1-500 to 1-300″ in length, and

from 1-6000 to 1-2200″ in breadth. They mostly contain elongated, dark-looking nuclei, 1-1100 to 1-400″ in length; these are well seen in a colourless hair, heated with soda or potash (fig. 294 *A b*, and *B*); in

Fig. 294.



Magnified 350 diameters.

A, Portion of a white hair after treatment with soda. *a*, nucleated cells of medulla, free from air; *b*, cortical substance with fibrillation and linear nuclei; *c*, cuticle. *B*, three isolated nuclei from the cortex.

coloured hair they also contain pigment-granules, to which the colour of the hair is principally owing. The pigment-granules are exceedingly minute, about 1-50,000″ in diameter, rounded, and, as existing in the hair, are mostly arranged in linear groups, their colour and number varying with that of the hair. The pigment-granules are best separated by the action of caustic potash or soda, and they frequently exhibit molecular motion.

The striated and dotted appearance of the shaft of hairs is not produced simply by the nuclei, nor by the pigment, but arises in part also from the unequal refraction of the light by the various parts of the cells, and from the presence of minute spaces filled with air. The nature of each can always be determined by attention to the principles laid down in the Introduction.

Towards the bulb, the cells of the cortex are more distinct, less elongated, and, as well as the nuclei, more easily isolated when treated with acids (fig. 295), whilst in the

Fig. 295.

Fig. 296.

Magnified 350 diameters.

Fig. 295. Two striated cells from the cortex of the root close above the bulb, with nuclei.

Fig. 296. Cells from the deepest portions of the bulb: *a*, from a coloured bulb, with pigment-granules and partly concealed nuclei; *b*, from a white hair, with distinct nuclei and a few granules.

bulb itself they are round (fig. 296), 1-4000 to 1-1800″ in diameter, closely crowded, and sometimes containing only a colourless nucleus, at others pigment-granules.

The *medulla*, like the cortex, consists of a number of cells. Its structure is best observed in a hair which has been treated with soda or potash. The cells are then seen to be arranged in one or more linear series (fig. 294 *a*); they are angular or rounded, 1-2000 to 1-1000″ in diameter; and if the action of the alkali has not been too long continued, they exhibit a nucleus; they frequently also contain one or more granules or globules of fat (fig. 297). In the shaft and

Fig. 297.

Magnified 360 diameters.

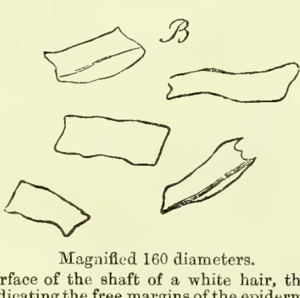
Medullary cells with pale nuclei and fatty granules, from a hair treated with soda.

upper part of the root of the hair, these cells contain air, which gives them a dark or black appearance by transmitted light; and it was the generally received opinion, until we pointed out the error several years ago, that this darkness or blackness arose from the presence of pigment. The contrary, however, may be easily proved by macerating the hair in oil of turpentine or any

liquid, when the air escapes in bubbles and becomes displaced by the liquid; moreover, on drying the hair, the air and black appearance return. Pl. 22. fig. 1 represents a white hair, in which the medullary cells of the lower part are filled with Canada balsam, whilst those of the upper portion still contain air. Again, examination by reflected light is equally conclusive; for under it the black medullary portions become white, which would not be the case did the blackness arise from pigment. Pl. 22. fig. 9 illustrates this in the hair of the Lion; where *a* represents the hair as seen by transmitted, and *b* by reflected light.

Cuticular coat. The shaft and root of the hair, above the termination of the inner root-sheath, are coated externally by a firmly adherent, thin, simple, membranous layer, consisting of flat, imbricated, epithelial scales. In the natural state of the hair, the existence of these scales is only indicated by the presence of irregularly transverse and anastomosing lines seen upon the surface, or slight dentition of the margin (fig. 298 *A*). But when the hair has been

Fig. 298.

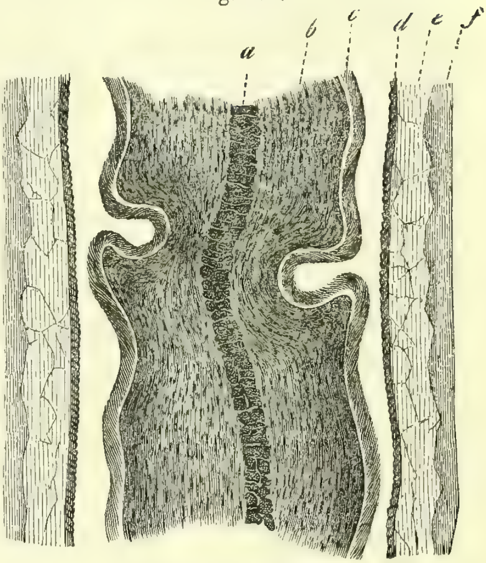


Magnified 160 diameters.

A, surface of the shaft of a white hair, the curved lines indicating the free margins of the epidermic scales. *B*, scales isolated by the action of soda.

treated with an acid or an alkali, the scales become separated. Their free margins are directed towards the unattached end of the hair. The scales are much more distinct without treatment, in the hair of the newly-born infant (Pl. 22. fig. 3). They are very

Fig. 299.



Magnified 250 diameters.

Portion of the root of a dark hair, slightly acted upon by soda: *a*, medulla, the cells still containing air; *b*, cortex with pigment; *c*, inner cuticular layer; *d*, outer cuticular layer; *e*, inner layer of the inner root-sheath; *f*, outer perforated layer of the same.

transparent, somewhat quadrangular, flattened or curved cells (fig. 298 *B*), not containing a nucleus; their margins or edges are often black, and, as the other parts are transparent, they are apt to be overlooked. They are about 1-700 to 1-500″ in length, and one half or one third of this in diameter.

In the lower part of the root, below the termination of the root-sheath, the cuticular coat is double, or consists of two layers. The above-mentioned cuticle of the shaft and upper part of the root forms the continuation of the innermost of these, which possesses nearly the same structure, except that the scales of which it consists are somewhat longer, and directed more obliquely outwards. These layers are best seen in a hair treated with an alkali, especially with the aid of pressure; they then become separated (fig. 299), the inner, with the root of the hair, assuming an undulating form, and remaining firmly adherent (*c*), whilst the outer (*d*) remains attached to the inner root-sheath, its cells also being broad and without nuclei. At the bulb, both these layers become transformed into soft cells, broader than long, with transverse nuclei,

finally becoming fused with the round cells of the bulb.

The *hair-follicles* are pouches, about 1-10 to 1-4′ in length, pretty closely surrounding the hairs, and extending in the short hairs into the substance of the upper layer of the cutis; but in the long hairs, into its deepest portion, or even into the subcutaneous cellular tissue. They may be regarded as prolongations of the skin, with its components, the cutis, basement-membrane, and epidermis. Hence three parts are distinguishable in them: an external, fibrous, very vascular portion—the proper hair-follicle; a basement-membrane; and a non-vascular cellular coat—the epidermis of the follicle, or, because it surrounds the root of the hair, the root-sheath.

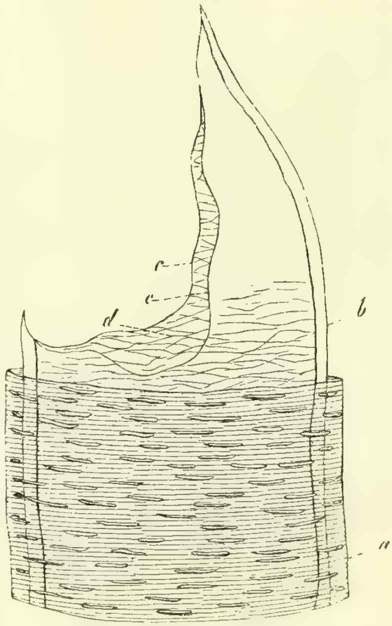
The fibrous portion of the follicle consists of two layers or membranes. The outer one (fig. 292 *h*) is the thicker, and contains vessels and nerves. Its inner surface is connected with the inner layer; externally it is attached to the surrounding areolar tissue; and above, it is continuous with the outer layer of the cutis. It consists of common areolar tissue, the fibres of which are longitudinal, with elongated spindle-shaped nuclei. The inner layer (fig. 300 *a*) is much more delicate, and only extends from the base of the hair-follicle to the orifice of the sebaceous follicles. It consists of a single layer of transverse fibres, with long and narrow nuclei, resembling unstriated muscular fibres.

The third layer (fig. 300 *b*), or basement-membrane, is transparent and structureless, and extends from the base of the follicle, without apparently covering the papilla, as far as the inner root-sheath, and perhaps higher. It presents delicate transverse anastomosing lines, producing a fibrous appearance.

The *pulp* or papilla of the hair (fig. 292 *i*) belongs to the follicle, and corresponds to a papilla of the skin. It is rounded or oval, 1-96 to 1-480″ in length, is connected with the fibrous coat of the follicle by a kind of stalk, and consists of indistinctly fibrous areolar tissue with nuclei and granules of fat, but contains no cells.

The two *root-sheaths* consist of the epidermic covering of the hair-follicle. The *outer* (fig. 292 *f*) is the continuation of the rete mucosum of the skin, and lines the entire follicle. Its lower part is in contact externally with the basement-membrane of the follicle; but above the termination of the inner transverse layer of the follicle, it is in direct contact with the outer or longitudinal layer. It consists of several layers of nucleated cells, resembling those of the rete mucosum of the skin, the outer having their long axis perpendicular to that of the hair, the others, especially towards the bulb, being rounded. This outer root-sheath is most distinct in the follicles of the skin of the negro, from which it may be withdrawn with the epidermis after maceration.

Fig. 300.



Magnified 300 diameters.

Portion of the inner fibrous coat and basement-membrane of a hair-follicle: *a*, inner coat with transverse fibres and elongated transverse nuclei; *b*, basement-membrane, seen as it were in section; *c*, its lacerated margins; *d*, fine lines (fibres?) on its inner surface.

The *inner root-sheath* (fig. 299, *e*, *f*) forms a transparent, very firm and elastic, yellowish membrane, extending from near the base of the hair-follicle to near the mouths of the sebaceous follicles, where it terminates abruptly with a jagged margin. Externally it is connected with the outer root-sheath, internally with the outer layer of the cuticle of the hair; hence no interval exists naturally between it and the hair. At first sight it appears as a perfectly homogeneous mem-

brane, but on closer examination it is seen to be distinctly cellular; it consists of two or three layers of polygonal, longish, transparent cells, with their long axis parallel to that of the hair. The *outermost* (Henle's) layer (figs. 299*f*, 301 *A*) consists of long,

Fig. 301.

Magnified 350 diameters.

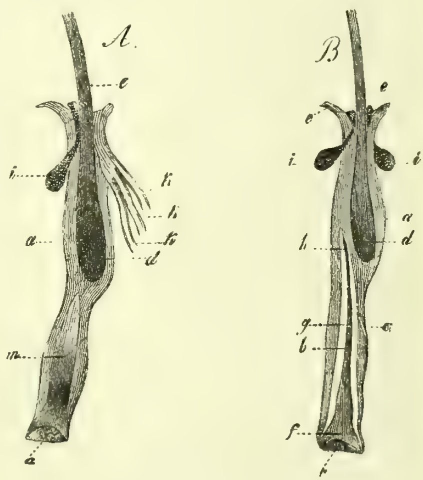
Elements of the inner root-sheath. *A*, external layer: 1, isolated plates; 2, the same in connexion, showing the interspaces (*a*) between the cells (*b*). *B*, cells of the inner non-perforated layer. *C*, nucleated cells of the lower part of the inner sheath, which consists of a single layer only.

flattened, non-nucleated cells, from 1-700 to 1-500″ in length, with fissures between them, forming a fenestrated layer. The *innermost* (Huxley's) layer (figs. 299*e*, 301*B*) consists of one or two layers of shorter and broader polygonal cells, from 1-1200 to 1-600″ in length; their nuclei, which exist in the lower part only of the coat, are often broader at the ends than in the middle, sometimes curved and pointed. At the base of the hair-follicle, the inner root-sheath consists of a single layer only of beautiful, polygonal, nucleated cells (fig. 301 *c*); these becoming soft, delicate and rounded, gradually pass into the outer layers of the round cells of the bulb.

In regard to *development*, the rudiments of the hair appear as processes of the rete mucosum descending into the substance of the cutis. These are solid, and consist of cells, the internal of which become horny and form first a small slender hair in the axis of the process, next an inner sheath surrounding the former, whilst the outer cells remain soft, and form the outer sheath and the cells of the bulb.

After birth the fœtal hair appears to be completely shed, new hairs being formed in the old follicles, which displace the first set, as shown in figs. 302, 303.

Fig. 302. Fig. 303.



Magnified 20 diameters.

Eye-lashes of a child a year old. *A* exhibits a process (*m*) of the bulb or outer root-sheath, in which the central cells are elongated, and form a cone distinct from the outer cells. *B*, one more advanced, in which the inner cone has become developed into a hair and an inner root-sheath: *a*, outer, *b*, inner root-sheath of the young hair; *c*, pit for the pulp; *d*, bulb; *e*, shaft of the old hair; *f*, bulb, *g*, shaft, *h*, summit of the young hair; *i*, sebaceous follicles; *k*, three sudoriparous ducts opening into the upper part of the hair-follicle.

The hairs sometimes found developed upon mucous membranes, and within encysted tumours and ovarian cysts, possess the normal structure in every respect.

Of the morbid states of the human hair, we need mention only the loss and change

of colour, and the presence of fungi. When the colour entirely vanishes, and the hair becomes white or grey, the cells of the medulla contain abundance of air. This arises from a kind of degeneration or impaired nutrition; the liquid contents of the cells are not supplied in sufficient quantity; they therefore evaporate, and the cells being prevented from collapsing by their adhesion to each other and to the firm cortex, become filled with air, which replaces what would otherwise constitute a vacuum. Fungi are found in FAVUS upon the cortex of the hair, within the follicles, and even within the hair itself, as is stated. In Porrigo decalvans also, fungi are stated to occur in the hairs; we can affirm positively that this is not correct, even when the disease has lasted for years.

The principal differences between the hair of man and of animals, and that of animals from each other, relate to—1, the size; 2, the relative proportions of the cortical and medullary structures; 3, the locality of the pigment; 4, the arrangement of the medullary cells; 5, the comparative amount of true hair, and woolly hair, down, or wool; and 6, the size and projection of the superficial cortical cells or scales.

Of these we shall give a brief sketch (Pl. 1. figs. 1–3, and Pl. 22).

The hair of the Mammalia generally is formed upon the same plan as that of man; great variety, however, exists in its complexity of structure and the arrangement of the component parts.

Quadrumana (Pl. 22. figs. 4 & 5). In the monkey (Indian) (fig. 4), the hair presents much of the same structure as in man; the pigment is confined to the cortex, but the air-cells of the medulla are larger and less crowded; this is seen to a greater extent in the hair of the lemur (fig. 5).

Cheiroptera. In the bats (Pl. 1. fig. 2; Pl. 22. figs. 6 & 7), a striking character is the peculiar development of the cortical scales of the surface. In the hair of the common bat (Pl. 1. fig. 2), which is one of the TEST-OBJECTS, and Australian bat (Pl. 22. fig. 7), this character is not so striking as in that of the Indian bat (Pl. 22. fig. 6), in which the scales are grouped in whorls at pretty regular intervals along the shaft, and project considerably beyond the surface. The pigment is principally confined to these whorled scales. In some of the white hairs of the bat, the individual scales are very beautifully seen (Pl. 1. fig. 2 *c*).

Insectivora. The hair of the mole (fig. 8) bears some resemblance to that of the bats; but the cells of the medulla are very distinct. (See SPINES.)

Carnivora (figs. 9–13). In this Order the structure of the hair varies considerably. In the lion (fig. 9) the cortical cells are distinct, but not projecting; the medullary cells are very numerous, and the air-spaces minute, but closely aggregated, as we often find them in the human hair. In the bear (fig. 10), the large hairs present much the same structure as in the lion; the wool-hairs differ strikingly from these, however, in the distinctness of the cortical and medullary cells.

Pachydermata (figs. 14–17). In this Order the hairs present a development corresponding with that of the skin; being very thick and complex in structure. In the elephant (fig. 15, transverse section), each hair resembles a number of hairs fused together. Scattered through its substance are pale spots formed by cells containing little or no pigment, with an irregular perforation in each, probably arising from rupture of the cells. Surrounding these medullary centres are innumerable cortical cells loaded with pigment. In the pig (fig. 16), the distinction between the cortex and medulla is not well marked, and the cells assume a radial direction, as indicated by those which contain most pigment. In the Cheiropotamus (fig. 17) the distinction is more evident.

Ruminantia (figs. 18–22). In this Order the hair presents great variety. In the camel (fig. 18) and dromedary (fig. 19), the true hair exhibits much the same structure as that of the higher Orders, whilst in the deer (fig. 20, moose-deer; fig. 21, musk-deer) the medullary portion is enormously developed at the expense of the cortical portion; in no hair is the cellular structure more distinct than in the two latter, the medulla closely resembling a piece of vegetable cellular tissue. The wool-hair in this class presents the characteristic structure. That of the camel (fig. 18 *b*) agrees in structure with the type of wool from the sheep (fig. 22) in its softness, flexibility and waviness, and in the distinctness of the cortical cells.

Edentata (figs. 23 & 24). The difference between the hair of the three-toed sloth (fig. 23) and that of the armadillo (fig. 24) is well-marked. In the former, the cortical cells take a remarkably oblique or radiating course, whilst in the latter they run longitudinally.

Rodentia (figs. 25–35). In this Order the pigment is met with sometimes in the medulla, at others in the cortex. The arrangement of the air-cells is often very beautiful, and has rendered these hairs favourite microscopic objects. Portions of a mouse-hair in various parts of its length are represented in fig. 27, *a* forming the free end. Fig. 28 displays two portions of the same hair as analyzed by treatment with solution of potash. The cortical parts have not been resolved into their component cells, whilst those of the medulla have assumed their rounded and natural form, and exhibit minute granules of pigment, with larger globules of fat. The arrangement of the medullary cells in two rows is seen in fig. 28 *b*. The pigment within the cells *in situ* is seen in fig. 31 *b*, from the rabbit. The wool presents its characters in a marked degree, the projection of the outer layer of cortical cells and the distinctness of the medullary air-cells being very evident.

Marsupialia (figs. 36 & 37). In this curious Order the hair greatly resembles that of the rodents. That of the Kangaroo presents very beautifully imbricated cortical cells (fig. 36).

Monotremata. The structure of the hair of the Ornithorhynchus is as peculiar as that of the animal in general. It presents that of hair and wool combined (fig. 38). The basal portion resembles wool, and is very long and narrow; the structure of two pieces in different parts of its length is seen in fig. 38 *c* and *d*. At the end of this portion is attached the proper hair containing the pigment within the cortical substance (*b*); fig. 38* represents the surface-view of the hair, showing the imbricated scales.

In Birds the hair is replaced by FEATHERS.

The hair of the Invertebrata does not present the same structure as that of the higher animals; some physiologists have therefore limited the term hair to the filiform epidermic formations of the Mammalia, whilst others admit the occurrence of hair in all classes of the animal kingdom. At all events, the hairs of the Invertebrata are not usually composed wholly of epidermis. They consist of an outer cortical or epidermic layer, frequently coloured, and upon which their firmness depends; lining this is sometimes a prolongation of the cutis, at others a colourless substance which, when the hair is dried, presents an irregular cell-like appearance and contains air, so as to resemble the hair-cells of the hair of the Mammalia. In other instances the hair is completely solid, but exhibits no trace whatever of cell-structure. It remains to be shown whether the latter may represent the epidermis hardened in an amorphous state, and whether those lined with cutis may be regarded as epidermic formations upon an exserted papilla of the skin, whilst those presenting the air-cells when dried correspond to an outer hardened epidermic layer, and an inner retaining its distinctly cellular state. In those lined with cutis, the circulation can sometimes be observed.

We have space to notice only a few instances of variety of form, many of which occur, and have long rendered these hairs interesting and elegant microscopic objects. Thus, in some of the Arachnida they are feathery, giving off slender lateral branches, as in *Lycosa* (Pl. 22. fig. 40), *Epeira* (Pl. 2. fig. 8 *a*), *Acarus* (Pl. 2. fig. 1 *b*), &c.; in others these branches are directed forwards near the middle of the shaft, but recurved at the end, as in *Mygale* (the bird-catching spider) (Pl. 22. fig. 41); or, while the branches on the shaft resemble the above, the end of the hair is thickened, cylindrical and longitudinally striated, with minute setæ arising from the striæ, as in fig. 42; again, some of them are simple, but furnished with spiral striæ (*Epeira*, Pl. 2. fig. 8 *b*); in *Trombidium* they are sometimes very elegantly feathery.

In Insects, Arachnida, &c., they often appear to rise from a bulb at the base; but the bulb is not solid, and bears no resemblance in structure to the bulb in the Mammalia; it consists of a thickening or fold of the epidermis of the skin, not of the hair, from which it is separated by a white ring, indicating thinness of this coat, and often corresponding to a joint; the hair arises from the base of a depression situated within the annular bulb. The hair of some of the larvæ of the Dermestidæ is very beautiful, and is used as a TEST-OBJECT. Two forms are met with: in one (Pl. 1. fig. 1 *c*) the shaft is simply covered with densely aggregated, minute, spinous, secondary hairs; in the other (Pl. 1. fig. 1 *a*, *b*), the spines or scales upon the shaft are narrow, acute, and placed in pretty regular whorls; in the uppermost whorl they are broader, the spines remaining as midribs, whilst the margins are more developed, the whole resembling a flower with four or five petals; but at the end of the hair, the scales are longer, narrower, and recurved,

each midrib being terminated below by a little knob.

The examination of the hair, and its dissection can only be effected by the aid of chemical reagents, especially sulphuric acid, solution of potash or of soda. These should first be used cold; and if no separation of the components ensues, heat even to boiling must be applied; the subsequent addition of water is sometimes advantageous. Sections of hair can be made with a razor, a bundle of hair being fixed between two flat pieces of cork, or between two cards. Transverse sections of the human hair can be obtained by shaving a second time, an hour or two after the first; the sections should then be washed in water. The cortical cells are most beautifully seen in white hairs which have been thoroughly soaked in oil of turpentine, and mounted in Canada balsam. The air-cells of the medulla are best observed in hairs which have been mounted in balsam without the previous application of turpentine. The sheaths of the hair keep best in solution of chloride of calcium or glycerine.

Many of the structures of the hair of the Mammalia may be well observed in the large hairs or bristles (whiskers) of the ox, &c.; in these also the pulp is seen to contain blood-vessels, which have not been detected with certainty in that of man.

The hairs of some animals polarize light. An interesting object of this kind may be made by placing two series of the white hairs of a horse in balsam, so as to cross each other at an angle, and viewing them by polarized light (Pl. 31. fig. 39).

In regard to the discrimination of the hairs of one animal from those of another, we believe that the examination of individual hairs can in general be but little depended upon; whilst a comparison of their form, length, and breadth, with the proportion of the true hair to that of the wool, conjoined with the consideration of the internal structure, may often enable an observer to arrive at a satisfactory conclusion.

Bibl. Kölliker, *Mikr.*; Eble, *Die Lehre v. d. Haar. in d. gesammt. organ. Natur*; Henle, *Allg. Anat.*, and *Fror. Notiz.* 1840; Todd & Bowman, *Phys. of Man*; Erdl, *München. Abh.* Bd. iii.; Huxley, *Med. Gaz.* 1845; Heusinger, *Syst. d. Histol.*; Gurlt, *Müll. Archiv*, 1836; Aikin, *Arts and Manuf.*; Donders, *Mulder's Physiol. Chem.*; De Morgan, *Phil. Trans.* 1859 (*Crustacea*); Pfaff, *D. mensch. Haar. in phys., pathol., & forensch. Bedeut.* 1869; Goette, *Schultze's Archiv*, 1868, p. 273; Stricker, *Handb. &c.*; Hofmann, *M. M. Jn.* 1873, p. 167; Frey, *Histolog. &c.*

HAIRS of Plants.—The term hair is applied in botany to filamentous productions upon the surface of the organs of plants, consisting of one or more cells arising out of and constituting part of the epidermal structure. Hairs of plants present a great variety of conditions: in the simplest kind —those composed of a *simple*, cylindrical, conical, bifurcated or stellate cell—they may be varied in *form* by the peculiar shape of the constituent cell, in *individual character* by the presence or absence of special secretions in the cell-cavities, and in their *collective character* by the mode of arrangement on the epidermis, since they may be few and scattered, or so numerous as to form a velvety coat. *Compound* hairs, namely those composed of a number of cells, vary in like manner, and, moreover, in the examples where the cell-walls acquire considerable thickness, pass gradually from pure *hairs* into *bristles*, and thence into the structures called Thorns (distinguished from true spines by being appendages of the epidermis). The stellate forms also present many variations intermediate between hairs proper and Scales.

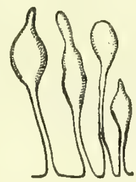
These structures are interesting to the microscopist on account of the variety and often extreme elegance or curiosity of their forms. They likewise strongly attract the attention of the physiologist from the simplicity of their organization and their free condition, allowing the phenomena presented by the cell-contents to be readily observed under the microscope. In reference to their characters as microscopic objects, it will suffice to indicate their principal modifications, and state a certain number of examples. For this purpose they may be classified as follows:—

Simple hairs: unbranched, Cabbage-leaf (*Brassica*, fig. 304), *Œnothera*, *Dictamnus* (Pl. 21. fig. 39 *a*), *Anchusa* (Pl. 21. fig. 17); *bifurcated*, *Capsella* (Pl. 21. fig. 36), *Draba* (fig. 307); *inflated* or *capitate*, *Antirrhinum* (fig. 306 and Pl. 21. fig. 34), *Salvia* (fig. 305), *Helleborus fœtidus*; *branched*, in many Cruciferæ, as *Sisymbrium Sophia* (Pl. 21. fig. 35), *Alternanthera axillaris* (Pl. 21. fig. 37); *stellate*, *Alyssum* (fig. 308). Very often hairs composed of a single cell are supported upon a short stalk, and then developed horizon-

tally in two directions, as in *Grevillia lithidophylla* (Pl. 21. fig. 29); in several so as to form a star, as in *Deutzia scabra* (Pl. 21. fig. 26*), *Alyssum* (Pl. 21. fig. 28). Structures analogous to the last occur upon the septa of the air-cavities of the Nymphæaceæ, such as *Nuphar lutea* (Pl. 21. fig. 15), *Victoria*, &c.

Fig. 304.


Fig. 305.


Fig. 306.


Hairs of:—
Brassica (leaf). Salvia (calyx). Antirrhinum (corolla).

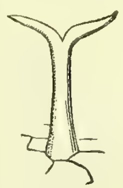
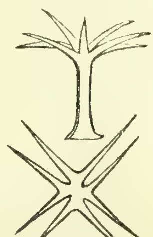
Fig. 307.


Fig. 308.


Draba (leaf). Alyssum (leaf).
Magnified 100 diameters.

Compound Hairs. These exhibit a similar diversity of character, and often imitate, on a larger scale, the forms of the simple hairs; they may be *unbranched*, as in the hairs of the garden *Pelargonia* (Pl. 21. fig. 18), and a large proportion of ordinary silky hairs upon the epidermis of plants. Cotton is a striking example, consisting of the hairs of the seeds of *Gossypium* (Pl. 21. fig. 1).

Commonly these hairs are cylindrical; but not unfrequently one or more of the uppermost or all the component cells are expanded into a more or less globular form. *Capitate* glandular hairs often occur on corollas, and particularly on the inner scales of leaf-buds: examples—the bulbils of *Achimenes* (Pl. 21. fig. 32), the corolla of *Digitalis* (Pl. 21. fig. 33), *Lysimachia vulgaris* (Pl. 21. fig. 40), *Scrophularia nodosa* (Pl. 21. fig. 41), *Bryonia alba* (Pl. 21. fig. 42), the inner scales of the winter leaf-buds of the ash, &c. Or the hairs are *torulose*, as in *Lamium album*, the common white Dead-nettle; or *moniliform* or necklace-shaped, as on the stamens of *Tradescantia* (fig. 311), the Marvel of Peru (*Mirabilis*, fig. 309). The transition from these to the branched forms is presented commonly in the simpler forms of the *pappus* of the Compositæ, as in that of the Groundsel, which has *toothed* hairs; in other examples the lateral teeth grow out into branches, as in the species of *Hieracium* and other Compositæ, presenting *pinnate* or *plumose* forms, according to the extent of ramification. The seeds of *Catalpa Bungeana* bear a fringe the hairs of which resemble Pitted Ducts. *Verbascum Thapsus* (Pl. 21. fig. 19) has compound hairs branched at the joints. Compound hairs likewise exhibit the horizontal development; the hairs of the garden Chrysanthemum are horizontal navicular cells, supported on a tall articulated pedicle (Pl. 21. fig. 30); the stellate hairs of the Ivy (Pl. 21. fig. 27) are compound, and supported on a short stalk-cell. Very varied forms of compound, more or less stellate, hairs occur on the leaves in the orders Jasminaceæ and Oleaceæ. The last form a transition to the scales of the Eleagnaceæ and many ferns, such as *Acrostichum*.

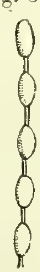
Fig. 309.


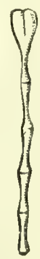
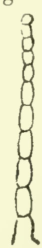
Fig. 310.


Fig. 311.


Hairs of:—
Mirabilis. Antirrhinum (calyx). Tradescantia (stamen).
Magnified 100 diameters.

The hairs above noticed are mostly solitary. In the Malvaceæ (*Hibiscus*) tufted or stellate groups of hairs are met with; and in the air-cells of *Utricularia* are seen curious groups of four hairs. *Marrubium creticum* is another example of this kind of structure (Pl. 21. fig. 47).

Almost all of the above-described forms of hair may contain merely watery colourless or coloured contents; or they may have one or more of the component cells filled with special oily, resinous, or saccharine

secretion. In the latter condition they are termed *glandular hairs.* The characters of these organs are spoken of under the head of GLANDS and SECRETING ORGANS of PLANTS. It has not been thought worth while to separate them in this article.

Some of the hairs with watery cell-contents present favourable opportunities for observing the ROTATION of the protoplasm; for example, the young hairs of the stamens of the *Tradescantia* (or spider-wort of gardeners) before they have acquired their moniliform character and dark contents; the stinging hairs of nettles also show this when young; and probably it might be observed in all young hairs, where sufficiently transparent and uninjured. One precaution greatly facilitates the observation—namely, to dip the hairs into alcohol for an instant, and immediately plunge them in water; after this operation, the structure is readily wetted by water, and no longer obscured by the abundance of air-bubbles that remain entangled with and adherent to the surface of the fresh hairs. These young hairs likewise exhibit at their apices the various conditions of the contents (nucleus, protoplasm, &c.) of cells multiplying by division (Pl. 38. figs. 8 & 9). The circulation takes place in the dark streaks represented as forming a network connected with the nuclei (*n*).

Stings, such as those of the Nettle (Pl. 21. fig. 8), consist of simple cells having a bulbous base enclosed in a cellular case, formed by the growing-up of the epidermis round the base of the hair; the latter tapers away upward to near the apex, where it again expands into a little globular head. The walls are rather thick and spirally striated. The bulbous base is filled with the irritating liquid, which exudes when the knob-like head is broken off, through the tension of the cellular investment of the sac.

The intimate structure of the hairs of plants presents many points of interest. The cells are of course composed of a cellulose wall, with contents varying according to age and other circumstances. When young, they are always densely filled with protoplasm (Pl. 38. figs. 8 & 9), which becomes gradually excavated by vacuoles, and expanded so as to form a mere reticulation or a few streaks upon the wall, mostly connected with an evident nucleus. The cavity of the cell is then filled, in hairs proper, with watery cell-sap, sometimes coloured, as in the petals and stamens of many flowers, by the same liquid colouring-matter as the cells beneath the epidermis; stings are filled with acrid watery juice,—glandular hairs with various secretions, which, like the watery juices, appear at first in vacuoles, gradually occupying the place of the protoplasm which follows the expanding cell-walls.

Hairs, being epidermal structures, possess a more or less evident cuticular layer, which may be detached by the action of acids (fig. 199, p. 283); sulphuric acid often causes this to separate and expand as a kind of vesicle from the surface of the hair, as is shown in Pl. 21. fig. 13 (*Siphocampylus*); the cuticle of the full-grown moniliform hairs of *Tradescantia* may be separated in like manner (see EPIDERMIS). This *cuticle* also exhibits in many cases the same markings which occur on the surface of the epidermis of certain plants, as *Helleborus*, *Cakile*, &c. (Pl. 21. figs. 9 & 10), consisting of elevated spots, ridges, reticulations, &c. composed entirely of thickenings of the cuticular layer. This is well seen in the hairs of the Boraginaceæ, e. g. *Anchusa* (Pl. 21. fig. 17), the Cruciferæ, as of *Farsetia*, *Cheiranthus*, &c., or *Delphinium* (Pl. 21. fig. 16). The spiral striæ on the sting of *Urtica urens* (Pl. 21. fig. 8) appear to be of similar nature. T. West has described the raised markings upon some hairs as bulgings or wrinkles in the cell-wall.

Finally, it is necessary to mention the remarkable structure of the hairs upon the surface of the seeds and pericarps of certain plants among the Acanthaceæ, Polemoniaceæ, Labiatæ, Compositæ, &c. Those of the ACANTHACEÆ have been spoken of partly under that head and under ACANTHODIUM. They are hairs composed of cylindrical cells, simple (*Ruellia*, Pl. 21. fig. 21), or conjoined into a compound and branched hair (*Acanthodium*, Pl. 21. fig. 24), the cell-walls of which receive when young a spiral (fig. 24) or annular (fig. 21) fibrous deposit, and subsequently become partially disorganized; so that, if placed in water in the mature state, the primary cell-wall almost dissolves into a kind of jelly, and the spiral-fibrous structure expands with elasticity. The conditions are similar in *Collomia* (Pl. 21. fig. 22), and, according to Schleiden, in *Gilia*, *Ipomopsis*, *Polemonium*, *Cantua*, &c. among the Polemoniaceæ, and somewhat the same in many species of *Salvia* (Pl. 21. fig. 23), *Ocymum*, *Dracocephalum moldavicum*, &c. among the Labiatæ. In *Cobæa scandens*, the spiral-fibrous hairs take rather the form of minute scales, and

they do not spontaneously expand elastically (Pl. 21. fig. 20). Among the Compositæ, these spiral-fibrous hairs have been observed on the pericarp of *Ruckeria*, some species of *Trichocline*, *Euriops*, *Mesogramma*, *Doria Cluytiæfolia*, *Oligothrix gracilis*, and some species of *Senecio*. Spiral cells also occur on the seed of *Hydrocharis*. The best way to observe the elastically expanding hairs is to place a thin slice of the skin of the seed on a slide, in a little alcohol, which does not soften the cell-wall: when the object is in focus, the addition of a little water causes the gelatinous softening of the cell-walls, the spiral fibres fly out from the surface of the seed-coat and show clearly the character of these beautiful objects. The primary membrane may be detected, even in its gelatinous state, by adding sulphuric acid and iodine, which produce a purplish or violet colour. Further remarks on this head will be found under SPIRAL STRUCTURES.

The hairs on the stigma of *Campanula* are remarkable for the intussusception which is observed to take place in mature hairs. The filiform processes growing from the under surface of the frondose Hepaticæ, the thallus of Lichens, the prothallium of Ferns, &c., are commonly called radical hairs. In most cases they present no remarkable points of structure; in *Marchantia*, however, peculiar spiral markings have been detected (see MARCHANTIA).

BIBL. Works on Struct. Bot.; Meyen, *Secretions-organe d. Pflanzen*, 1837; id. *Pflanzen-physiol.*; Cohn, *de Cuticula*, *Linnæa*, xxiii. p. 337, 1850; Schleiden, *Müller's Archiv*, 1838; *Beitr. z. Botanik*, Leipsic, 1844, i. p. 121 (*Scient. Memoirs*); Decaisne, *Ann. d. Sc. N.* 2 sér. xii. p. 251, pl. 4; Leighton, *Ann. N. H.* vi. p. 257; Brongniart, *Ann. d. Sc. Nat.* 2 sér. xii. p. 244, pl. 4; Prillieux, *Ann. d. Sc. Nat.* 4 sér. v. p. 5; Tuffen West, *Qu. Mic. Jn.* vii. p. 22; Weisse, *D. Pflanzenhaare*, 1867.

HALAC'ARUS, Gosse.—A genus of Arachnida, of the order Acarina.

Char. Body covered with a dorsal shield; rostrum bulbous, pointed; palpi terminated by a fang-like claw; legs formed for walking, directed two pairs forwards and two backwards, and with a pair of hooks; coxæ remote.

Two species: *H. rhodostigma* and *H. ctenopus*, found crawling upon sea-weeds at low water.

BIBL. Gosse, *Mar. Zool.* i. 177.

HALARACH'NE, Allman.—A genus of Arachnida, of the order Acarina, and family Gamasea.

Distinguished by the elongate subcylindrical body with an anterior dorsal plate, and the entozoal habitat.

H. halichœri. Found in the posterior nares of a seal (*Halichœrus Gryphus*); length 1-8″.

BIBL. Allman, *Ann. N. H.* 1847, xx. 47.

HALE'CIIDÆ, Hincks. A family of Hydroid Polypi.

Gen.: *Halecium* and *Ophiodes*.

HALE'CIUM, Oken.—A genus of Polypi, of the order Hydroida, and family Sertulariidæ.

Distinguished by the plant-like polypidom, the stem consisting of numerous parallel capillary tubes; and the cup-like nearly sessile cells, arising alternately on opposite sides of the stem, one under each joint.

H. halecinum. Vesicles oval or oblong. Common on shells and stones in deep water; 4-10″ high.

H. Beanii. Vesicles calceoliform. Rare.

H. muricatum. Vesicles spinous.

5 other species.

BIBL. Johnston, *Brit. Zooph.* 58; Hincks, *Hydroid Zooph.* p. 220.

HALICHOND'RIA, Flem.—A genus of SPONGES.

HAL'IDRYS, Lyngb.—A genus of Fucaceæ (Fucoid Algæ), containing one British species, *H. siliquosa*, common on rocks and stones somewhat above low-water mark. It is readily distinguished by its pod-like septate air-vessels. The fructification, which is terminal on the branches, much resembles that of FUCUS, except that the interior of the receptacles is filled up with firm polygonal cellular tissue. The antheridia, moreover, are terminal on their pedicels, often in tufts, short in form, and intermixed with spore-sacs in the same conceptacle.

BIBL. Harvey, *Br. Mar. Alg.* p. 15, pl. 1 C; Thuret, *Rech. s. les Anthérid.*, *Ann. d. Sc. Nat.* 3 sér. xvi. p. 8, pl. 3.

HALIO'NYX, Ehr.—A genus of Diatomaceæ.

Char. Frustules single; valves equal, circular, surface radiate, the rays not commencing at the umbilicus; no internal septa. Marine.

H. senarius. Rays six, the intervening spaces with shorter rays of equal length parallel to the larger, and with transverse

laxly cellular lines; umbilicus punctate, entire; diam. 1-720″.

H. undenarius (Pl. 43. fig. 51). Rays eleven or twelve.

Bibl. Ehr. *Ber. d. Berl. Akad.* 1844, p. 198.

HALISAR'CA, Duj. (Hymeniacidon, Bowerbk.).—A genus of marine Sponges.

Forms a thin semitransparent gelatinous amber crust on rocks and shells, with indistinct oscula and pores.

H. Dujardinii. The only species.

Bibl. Johnston, *Brit. Sponges*; Gosse, *Mar. Zool.* i. 6; Bowerbank, *Brit. Spong.* ii. p. 224.

HALIS'ERIS, Tozzetti.—A genus of Dictyotaceæ (Fucoid Algæ), containing one British species, with a brownish olive, sometimes forked frond with a midrib, from 4″ to 1′ high, having a very powerful offensive smell when fresh. The fructification is produced in sori, arranged in lines on each side of the midrib, or scattered, containing large spores.

Bibl. Harvey, *Br. Mar. Alg.* p. 36, pl. 6 B.

HALOCY'PRIS, Dana.—A marine Ostracod, with very thin, subquadrate, saddle-shaped valves, beaked in front at the upper angle. The closely allied *Conchœcia,* Dana, has longer and subrectangular valves. Both are related to *Cypridina,* and have two pairs of feet, weak upper antennæ, distinct mandibles, large frontal tentacle, and no eyes.

Living in the Atlantic and Mediterranean.

Bibl. Dana, *Expl. Exped. Crust.* 1301; Brady, *Tr. Linn. Soc.* xxvi. 469.

HALTE'RIA, Duj.—A genus of Infusoria, of the family Keronia (Halterina, Cl. and Lachm.).

Char. Body almost spherical or top-shaped, surrounded by long, very delicate, retracting cilia, which, by becoming adherent to the slide, and suddenly contracting, cause it to change its place suddenly, as if by leaping. A row of oblique very large cilia situated at the circumference of the body.

H. grandinella (= *Trichodina grandinella,* Ehr.) (Pl. 41. figs. 11, 12). It has two kinds of appendages on its surface: 1, straight, excessively delicate, radiating cilia, which appear to be the cause of its movements, which are so sudden, that even with the utmost attention it cannot be ascertained how they are produced; 2, very large cilia, arranged obliquely at the circumference of the body. Aquatic. Greatest breadth, 1-850″.

Stein points out the resemblance of this animalcule to the swarm-germs of an *Acineta* found upon *Cyclops.*

H. volvox. Berlin.

H. pulex. Marine.

Bibl. Dujardin, *Infus.* p. 414; Stein, *Infus.*; Cl. & Lach. *Inf.* p. 369.

HALTERI'NA, Cl. and Lach.—A family of Infusoria.

Gen.:

No setæ for leaping; animals essentially swimmers	*Strombidion.*
With fine setæ serving for leaping; animals leapers	*Halteria.*

HAL'TICA, Ill.—A genus of Coleopterous Insects; fam. Galerucidæ.

H. nemorum, the "turnip-fly." Oblong-ovate, black; elytra greenish black, with a broad uninterrupted sulphur-yellow streak, not reaching the apex. Movement jumping.

Bibl. Stephens, *Brit. Coleopt.* p. 291.

HALYME'NIA, Ag.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one British species, found on the southern shores. It is a somewhat palmate, membranous, rose-coloured sea-weed, usually from 6 to 12″ long, composed of a double membrane, the layers being separated by a loose network of jointed filaments. The fructification consists of favellidia buried in the frond, attached to the inner surface of the membranous laminæ, scattered all over the frond, appearing to the naked eye like red dots.

Bibl. Harvey, *Brit. Mar. Alg.* p. 148, pl. 19 D.

HAPALOSI'PHON, Näg.—A genus of Oscillatoriaceæ (Confervoid Algæ).

Char. Filaments sheathed, consisting of a single row of greenish-brown cells; sheath very delicate, colourless, indistinctly lamellate.

4 European species. Found on water-plants.

Bibl. Rabenhorst, *Fl. Alg.* ii. 283.

HAPLARIA, Link. See Botrytis *grisea.*

HAPLOMIT'RIUM, Nees.—A genus of Jungermannieæ (leafy Hepaticæ), containing one British species, *H.* (*Jungermannia*) *Hookeri,* an Alpine plant, which has been carefully studied by Gottsche. It is remarkable for having leaves (without *amphigastria*) inserted on all sides of the stem.

The terminal capsule emerges at length from a large oblong fleshy epigone (fig. 328). The antheridia (fig. 323) occur in the axils of the leaves; they have a double coat, the interior of which consists of reniform cells (fig. 322), which become isolated and more or less dissolved. The spermatozoids, produced in minute vesicles (fig. 324), resemble those of the Mosses.

BIBL. Hooker, *Brit. Jungermanniæ*, pl. 54; Ekart, *Synops. Jung.* pl. 8. fig. 65; Endlicher, *Gen. Plant.* No. 474–3; Gottsche, *Nova Acta*, xx. p. 265, pls. 13–20.

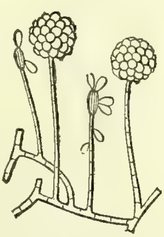
HAPLOPHRAG'MIUM, Reuss. — A sandy Lituoline Foraminifer, either nautiloid or crozier-shaped, with simple aperture and undivided chambers. Recent and fossil.

BIBL. Reuss, *Sitzungsb. Ak. Wien*, xliv. 381.

HAPLOSTICHE, Reuss. See LITUOLA.

HAPLOT'RICHUM, Link.—A genus of Mucedines (Hyphomycetous Fungi), intermediate in structure between *Botrytis* and *Aspergillus*. The spores are developed from a capitate cell terminating the septate erect fertile filaments (fig. 312).

Fig. 312.



Haplotrichum roseum. Magn. 200 diams.

BIBL. Corda, *Icon. Fung.*; Nees, *Syst. d. Pilze*, pl. 4; Fries, *Summa Veget.* p. 470.

HAR'TEA, Wright.—A genus of Alcyonidiadæ.

Polype solitary; body cylindrical, fixed at the base; tentacles 8, knobbed at their base; basal portion of body thickly studded with small star-shaped spicula; base and body of tentacles with long dendritic spicula; mouth central, with 2 lips; somatic chambers 8.

H. elegans. Height 3-4″. White, base dark. West coast of Ireland.

BIBL. E. S. Wright, *Qu. Mic. Jn.* 1865, v. p. 213 (pl.).

HARVEST-BUG. TROMBIDIUM *autumnale.*

HASSALLIA, Berk. See SIROSIPHON.

HAUERI'NA, D'Orb. — One of the *Miliolida*, growing on one plane, subdiscoidal, and characterized by a cribriform aperture.

H. compressa (Pl. 18. fig. 8). Fossil in the Tertiary beds; living in tropical seas; rare on the British coast.

BIBL. Carpenter, *Introd. For.* 81.

HAVERSIAN CANALS. See BONE.

HEART.—The muscular fibres of the heart present certain peculiarities. The primitive bundles are more slender than usual; they frequently anastomose, and contain normally a few minute granules of fat: the transverse striæ are also often indistinct. In disease the fatty matter is often extremely abundant (Pl. 30. fig. 14 *a*), and the striæ are more or less obliterated.

BIBL. Kölliker, *Mik. Anat.* ii.; Förster, *Path. Anat.*; Wedl, *Path. Histol.*; Quain, *Med. Chi. Trans.* 33; Rokitansky, *Path. Anat.*

HEDWIG'IA, Hook.—A genus of Mosses. See ZYGODON.

HEIBER'GIA, Grev.—A genus of Diatomaceæ.

Char. Fr. compressed, quadrilateral, cellulate, with a punctate surface of the angles, where they probably cohere; valves with one longitudinal and several transverse costæ, the longitudinal one terminating at each end in a blank space.

H. Barbadensis (Pl. 48. fig. 4). Barbadoes deposit.

BIBL. Grev. *Mic. Trans.* 1865, v. p. 100.

HELICO'MA, Corda.—A genus of Dematiei (Hyphomycetous Fungi), with the spores curled into a spiral. Mr. Berkeley considers the distinction between *Helicoma* and *Helicosporium* scarcely tenable, and Fries includes *Helicoma Mülleri*, Corda, under *Helicosporium*. This plant has been found on dead wood in this country.

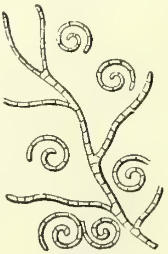
BIBL. Corda, *Icon. Fung.* i. pl. 4. fig. 219; Berkeley and Broome, *Ann. N. H.* 2nd ser. vii. 98; Fries, *Summa Veget.* p. 500.

HELICOSPOR'IUM, Nees.—A genus of Dematiei (Hyphomycetous Fungi), growing on decayed wood, nearly related to *Helicoma* and *Helichotrichum*. *Helicoma* and *Helicosporium* are described as having erect fertile filaments, *Helicotrichum* creeping branched filaments; but the distinctions are obscure, as also those between *Helicoma* and *Helicosporium*, the first of which should have the spirals closed, the latter open. Fries and Berkeley both include *Helicotrichum* under *Helicosporium*. British species:

H. pulvinatum, Fr. (fig. 313). Forming a blackish or olive pulvinate stratum over wood, with slender branched filaments, bearing yellowish-green strings of sporidia

coiled up into a spiral of about three turns, very fugacious (*Helicotrichum pulvinatum*, Nees).

Fig. 313.



Helicosporium pulvinatum.
Magn. 200 diams.

H. vegetum, Fr. Widely pulvinate-effused, suboli-vaceous, at length black; fertile filaments erect, stiff, subulate; spores coiled into a ring, 3-septate, greyish green.

Bibl. Berk. *Hook. Brit. Fl.* vol. ii. pt. 2. p. 335; *Ann. N. H.* 2nd ser. vi. p. 434; vii. p. 98; Fries, *Syst. Myc.* iii. p. 353; *Sum. Veg.* p. 500; Corda, *Sturm, Deutschl. Flora,* 3 ser. ii. pls. 15 & 16; Nees, *Nova Acta,* ix. 246, pl. 5. fig. 15; *Syst. Mycol.* p. 68, fig. 69.

HELICOSTE'GIA.—An order of Foraminifera, according to D'Orbigny's system, comprising those coiled spirally on a single axis. This feature, however, is common to several genera which have distinct characters of structure and habit, and has ceased to be regarded as typical.

HELICOT'RICHUM, Nees. See Helicosporium.

HELIOPEL'TA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single (?), orbicular in side view, internally furnished with imperfect radiating septa, the alternate intermediate portions of the valve being depressed; valves angular and not furnished with markings in the centre, but with as many large submarginal apertures (?) as there are rays, and with numerous erect opposite submarginal spines on each side. The spines connect the pairs of young frustules.

H. metii. Frustules with six septa and rays, three of the intervals raised and coarsely cellular, the alternate ones impressed with fine decussating lines, the limb of the radiate margin broad; marginal spines in the middle of each cellular interval one or three, in the others two or four; umbilical star slightly angular; diameter 1-370″. Bermuda.

Three other species, with a different number of rays. *H. Leeuwenhoeckii*, Pl. 19. fig. 4.

The different appearances of the markings upon the elevated and depressed portions of the valves evidently arise from the existence of the ordinary depressions seen naturally by oblique and direct light.

Bibl. Ehrenberg, *Berl. Ber.* 1844, p. 262; Greville, *Mic. Trans.* 1866, vi. p. 5 (*new sp.*).

HELMIN'THOSPO'RIUM, Link. — A genus of Dematiei (Hyphomycetous Fungi), growing on rotten wood &c., of which numerous species are found in Britain. Tulasne regards this genus as consisting of stylosporous forms of Sphæriacei. Currey refers to this genus Corda's *Dactylium* (Dendryphium) *fumosum.* The mycelium is often somewhat gelatinous or indistinct; on it arise (often aggregated) erect, rigid, septate filaments (*fibres*), on the summits of which stand large, often club-shaped septate spores. British species:

H. macrocarpum, Greville (*Sc. Crypt. Fl.* pl. 148. fig. 1).

H. subulatum, Nees (*Nova Acta,* ix. pl. 5. fig. 13).

H. Clavariarum, Desmazières (*Ann. d. Sc. Nat.* 2 sér. ii. pl. 2. fig. 2).

H. velutinum, Link (Grev. *Sc. Crypt. Fl.* pl. 148. fig. 2).

H. fusisporium, Berk. (*Br. Flora,* vol. ii. part 2. p. 336).

H. nanum, Nees (*Nova Acta,* ix. pl. 5. fig. 13 B; *System.* fig. 65).

H. simplex, Kunze (Nees, *l. c.* fig. 11).

H. Tiliæ, Fr. (Berkeley, *Ann. Nat. Hist.* vi. pl. 13. fig. 18).

H. folliculatum, Corda (*Icon. Fung.* i. pl. 3. fig. 180).

H. obovatum, Berk. (*Ann. N. H.* vi. pl. 13. fig. 19).

H. delicatulum, Berk. (*l. c.* fig. 20).

H. Smithii, Berk. and Broome (*Ann. N. H.* 2 ser. vii. pl. 5. fig. 5).

H. turbinatum, Berk. and Br. (*l. c.* fig. 6).

H. Rousselianum, Montagne (*Ann. d. Sc. Nat.* 3 sér. xii. p. 300).

H. stictitum, Berk. and Br. (*Ann. N. H.* 2nd ser. xiii. pl. 15. fig. 10).

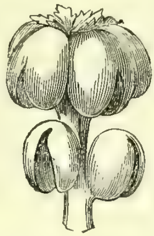
Bibl. Berkeley, *Brit. Fl.* iii. pt. 2. p. 336; Fries, *Syst.* iii. p. 354, and *Summa Veget.* p. 500; Currey, *Qu. Mic. Jn.* v. p. 115; Tulasne, *Ann. d. Sc. Nat.* 4 sér. v. 109.

HELMINTHOSTACHYS, Kaulf. — A genus of Ophioglossaceous Ferns, distinguished by the complex spikes bearing crested sporanges.

HELVEL'LA, L.—The typical genus of Helvellacei.

Several species occur in this country, amongst which *H. lacunosa* and *H. crispa* are esculent.

Fig. 314. Fig. 315.



Helminthostachys zeylanica.

Fig. 314. Fragment of a spike with sporanges. Magnified 10 diams.
Fig. 315. A portion still more magnified (20 diams.).

BIBL. Fr. *Syst. Myc.* vol. ii. p. 13; Berk. *Outl.* p. 358.

HELVELLA'CEI.—A family of Ascomycetous Fungi, approaching the Hymenomycetes in outward form, but distinguished at once by their fructification. See ASCOMYCETES, HELVELLA, SPATHULEA, LEOTIUM, STICTEI, PROPOLIS.

HEMELYT'RA.—The anterior pair of wings of the Heteropterous division of the Hemiptera. See INSECTS.

HEMERO'BIUS, Linn.—A genus of Neuropterous Insects.

Hemerobius (*Chrysopa*) *perla*, one of the lace-winged flies, has very thin, transparent, and beautifully netted iridescent wings, in which the circulation can be well observed; the wings also exhibit well the tracheæ in the veins. The larva feeds upon Aphides.

BIBL. Westwood, *Introd.&c.*; Bowerbank, *Entom. Mag.* iv.

HEMIAU'LUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, compressed, subquadrate, with two tubular processes on each side, the ends of those (the shorter) on one side being open, the others closed; not constricted at the sides.

H. antarcticus (Pl. 19. fig. 3).

The species (two) appear to consist of *Biddulphiæ* with the ends of two of the processes broken off.

BIBL. Ehrenberg, *Berl. Ber.* 1844, p. 199; Greville, *Ann. N. H.* xvi. p. 5; id. *Mic. Trans.* 1865, pp. 26, 52, 101.

HEMIDIS'CUS, Wall.—A genus of Diatomaceæ.

Char. Fr. free; valves arcuate, with a median marginal inferior nodule; areolation hexagonal, radiate.

H. cuneiformis. From *Salpæ*, Bay of Bengal and Indian Ocean.

BIBL. Wallich, *Mic. Trans.* 1860, viii. p. 42 (fig.).

HEMIONI'TIS, Linn.—A genus of Grammitideæ (Polypodioid Ferns), with a very elegant reticulated arrangement of the sori.

HEMIP'TERA.—An order of INSECTS.

HEMIP'TYCHUS, Ehr. See ARACHNOIDISCUS.

HEMITE'LIA, Presl.—A genus of Cyathæous Ferns. Exotic.

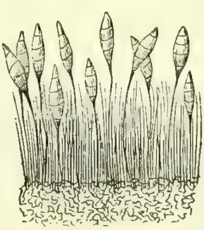
HEMIZOS'TER, Ehr.—A genus of siliceous fragments of some unknown substance or body!

BIBL. Ehrenberg, *Ber. d. Berl. Akad.* 1844, p. 199.

HEMP.—The ordinary name of the fibre of *Cannabis sativa*, consisting of the liber-fibres of this plant (Pl. 21. fig. 6). It is applied to some other substances used for the same purposes, *e. g.* Manilla-hemp (the fibre of MUSA) &c. See TEXTILE FIBRES and LIBER.

HENDERSO'NIA, Berkeley (*Sporocadus*, Corda, in part).—A genus of Sphæronemei (Coniomycetous Fungi), interesting as having furnished one of the earliest discovered examples of two forms of fructification, leading to the abolition of the distinction between Coniomycetous and Ascomycetous Fungi (CONIOMYCETES). Mr. Berkeley has seen two conditions of spores in *H. mutabilis*, and he states that Fries informs him of the observation of asci and septate naked spores (*stylospores*) conjointly in *Hendersonia Syringæ*. Several British species have been described. They form dark spots or patches on the stems of herbs or twigs of trees,—the dark matrix having a *perithecium* excavated in it, lined by a gelatinous stratum, on which

Fig. 316.



Hendersonia.
Spores on the perithecium.
Magnified 200 diams.

stand stalked fusiform septate spores (fig. 316).

H. elegans, Berk. (*Ann. Nat. Hist.* 1840, vi. pl. 11. fig. 9). On the culms of reeds.

H. macrospora, Berk. and Broome (*l. c.* 2nd ser. v. p. 373). On dead twigs of *Philadelphus*.

H. arcus, Berk. and Br. (*l.c.*). On Box twigs.

H. mutabilis, Berk. and Br. (*l. c.*). On dead twigs of Plane.

H. polycystis, Berk. and Br. (*l. c.*). On dead twigs of Birch.

H. macropus, Berk. and Br. (*l. c.*). On dead leaves of *Carex*.

H. typhoidearum, Desmazières (*Ann. des Sc. Nat.* 3 sér. xi. 344). On dead leaves of *Typha*, &c.

H. Stephensii, Berk. and Br. (*Ann. Nat. Hist.* 2 ser. viii. p. 95). On dead stems of *Pteris aquilina*.

H. fibriseta, Berk. (*Hooker's Jn. of Bot.* iv. p. 43). On birch planks.

BIBL. Berkeley, and Berk. and Broome, *Ann. N. H.* iv. p. 43; Hooker's *Jn. of Bot.* iii. 319; Fries, *Sum. Veg.* 416; Tulasne, *Ann. des Sc. Nat.* 4 sér. v. p. 115.

HEPATICÆ.—An order of the Muscales (Cryptogamous Plants), consisting of plants of small size, varying much in structure, inhabiting damp spots on the ground, rocks, or trees, or floating on water.

The vegetative structure of the lowest forms consists simply of a patch of green membrane, spreading over the ground, composed of a single (*Anthoceros lævis*) or double (*Sphærocarpus terrestris*) layer of cells containing chlorophyll. In *Marchantia* (see MARCHANTIA) there is an advance; the frond not only exhibits more definitely cha-

Fig. 317.

Fig. 318.

Fimbriaria fragrans.

Fig. 317. Lobe of a frond. Nat. size.
Fig. 318. Section of frond, showing two immersed antheridia. Magnified 40 diams.

racterized lobes, but also a considerable thickness, and a complexity of internal structure, since it possesses an epidermis investing both surfaces, and containing stomata on the upper (see STOMATA). The lower epidermis is also provided with numerous radical hairs (see HAIRS and SPIRAL STRUCTURES). *Fimbriaria* (fig. 318) and *Lunularia* (fig. 319), &c., likewise possess thick cellular fronds. In *Riccia* the frond also presents a reticulated upper face provided with stomata; but the form of the entire frond is usually elongated and bifurcated, and a slight groove runs along the

Fig. 319.

Lunularia vulgaris.
A frond in fruit. Nat. size.

middle line, almost like a mid-nerve. This central line exhibits a difference in the internal cellular structure, since it is composed of elongated cells, while the surrounding green substance is composed of spherical cells, such as constitute the entire mass enclosed between the upper and lower epidermis of the frond of *Marchantia*. The groove on the upper face (of *Riccia*) corresponds to a rib on the lower face, from which arise most of the radical filaments, while they are scattered indiscriminately over the lower face of *Marchantia*; and from this line also arise the little bodies resembling minute leaves, called *amphigastria*. If we suppose the frond of *Riccia* elongated and the mid-nerve more strongly marked, we have the likeness of *Blyttia Lyellii* (fig. 62, p. 101), while if this latter were notched down to the rib at intervals along each side, we should have the stem with two parallel rows of leaves, as in the Jungermannieæ.

The line of insertion of the leaves is seldom exactly parallel with the axis of the plant, and very rarely at right angles. In most cases it is more or less oblique, and the obliquity is in reverse direction at the two sides of the stem, so that the lines of insertion of two succeeding leaves would meet, if prolonged across the stem, in the form of a V (fig. 320).

The leaves are very frequently imbricated,

and they overlap in two ways: either each leaf covers with its lower edge a little of the leaf below it, or each leaf overlaps a little of the base of the leaf above it. In the first case, the leaves are called *succubous* (fig. 320), in the second *incubous* (fig. 321). The leaves vary much in form, and are often deeply toothed or bilobed, and form exceedingly elegant objects under the microscope.

Fig. 320.

Fig. 321.

Fig. 320. Radula complanata. Magn. 5 diams.
Fig. 321. Plagiochila undulata. Magn. 5 diams.

The leaves are accompanied in many cases, chiefly in the Jungermannieæ, by stipule-like leaflets, called *amphigastria*, situated at the underside of the stem.

These plants are reproduced by dust-like grains called *spores*, by minute cellular nodules called *gemmæ*, and by *innovations, i. e.* new lobes growing out from the margins of the old fronds, or buds in the axils of leaves, or on confervoid branches sent out from the stem.

The *gemmæ* of *Marchantia polymorpha* are produced in elegant membranous cups, with a toothed margin, growing on the upper surface of the frond, especially in very damp and imperfectly lighted situations; they are little cellular nodules at first attached by a stalk, and at a certain period fall off and grow up into a new frond. (See MARCHANTIA.)

The spores are produced in *sporanges* or *capsules*, the formation of which is preceded by special anatomical and physiological phenomena demonstrating the existence of distinct sexes in these plants. The organs which represent the anthers of flowering plants are called *antheridia*, those which represent the ovules, and produce the spore-cases, are called *archegonia* or *pistillidia*. The *antheridia* are small globular or oval bodies, more or less stalked, which in the Jungermannieæ are composed of a double layer of cells forming a membranous sac, which, when ripe, bursts and discharges numerous minute globular cellules, each of which again bursts and discharges an extremely small filament, which moves about actively in water (figs. 322 & 324). These

Fig. 322.

Fig. 323.

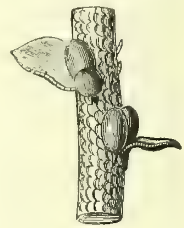
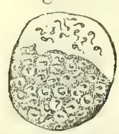


Fig. 324.



Haplomitrium Hookeri.

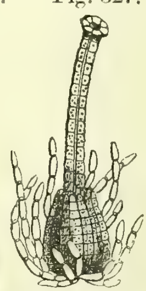
Fig. 322. Axillary antheridia. Magn. 30 diams.
Fig. 323. Fragment of wall of antheridia; the reniform loose cells belong to the inner layer. Magn. 200 diams.
Fig. 324. Spermatozoids from ditto. Magn. 200 diams.

organs mostly occur in the same situations as the *archegonia*; and in some of the frondose forms, such as *Anthoceros*, *Riccia*, *Fimbriaria* (fig. 318), &c., they are im-

Fig. 325.

Fig. 326.

Fig. 327.



Marchantia polymorpha.
Archegonia in various stages.
Magnified 100 diameters.

bedded in the substance of the frond; in others, as in *Marchantia*, they are immersed

in the upper part of special male stalked receptacles (see MARCHANTIA); in the leafy forms they are free in the axils of the leaves (fig. 323).

The *archegonia* or *pistillidia* are likewise developed in various places, indicated hereafter in the tabular view of the families. They consist of a kind of flask-shaped cellular case (figs. 325 to 327), enclosing at first a single cell (*embryonal cell*), which subsequently grows into a sporange, apparently after one or more of the spiral filaments of the antherids have come in contact with it, by passing into the neck of the flask-shaped sac (*epigone*). The embryonal cell becomes increased by cell-division into a globular cellular mass, which acquires various forms in the different genera and families. The epigone enlarges for a long time with the growing capsule, completely enclosing it (fig. 328); but after a time the latter bursts

Fig. 328.

Haplomitrium Hookeri.
Young sporange enclosed in the epigone.
Magnified 20 diameters.

through the top of the *epigone*, which thus forms a kind of sheath round the base of the sporange or its stalk, and is called the *vaginule*. The epigone may tear irregularly, so as to form an irregular *vaginule* or *calyx*, or regularly, so as to present a circle of teeth; or it may be slit horizontally in a circle, and half of it carried up by the sporange, which it thus surmounts as a hood or *calyptra*. This epigone is sometimes surrounded by another envelope called the *perigone*. This originates at a later period and in a different way, since it gradually springs up as a circular sheath around the base of the epigone, and by continued growth comes to surround it as a kind of cup, like the corolla of a flower (fig. 320). In *Marchantia*, only one archegone is found in each perigone; the perigones of Jungermannieæ always enclose several, but only one is developed into a sporange. In some kinds, as *Sarcoscyphus*, there are always several archegones in a perigone, and two or three produce sporanges. Sometimes the archegones, with or without perigones, are solitary; more frequently they are in groups. Whether solitary or grouped, they may have a further envelope composed of slightly modified leaves, free or confluent together; these are the *perichætial leaves*, and constitute the *perichæte*. When both *perichæte* and *perigone* exist, it is easy to determine which is which; but when only one exists, the history of development alone gives the key; the perichæte is always developed before the archegones it encloses, while the perigone, as already stated, grows up round the archegone during its development into a sporange, being absent at the time of the first appearance of that organ. In fig. 320 the base of the pedicel is seen to rise out of a toothed *vaginule* (*calyx* or *epigone*), which is enclosed in a tubular perigone, outside of which are two bilobed perichætial leaves.

The sporange developed from the embryonal cell of the archegone varies much in its perfect condition. In Jungermannieæ it is mostly an oval body borne on the extremity of a delicate thread-like stalk springing out of the *vaginule* (fig. 320). The oval body splits down from the summit, when ripe, into four valves, which spread open more or less in the form of a cross (figs. 320–1), or bursts irregularly. The cells of the valves exhibit very elegant spiral-fibrous structure, like that of the walls of anthers (see SPIRAL STRUCTURES). This kind of sporange discharges minute spores (see SPORES) and *elaters*, slender tubular cells containing a spiral filament (Pl. 32. fig. 38), both forming very interesting microscopic objects.

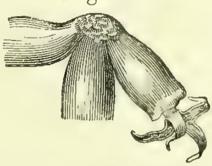
In the different frondose forms the sporanges present very varied conditions. The archegones of ANTHOCEROS send up a filiform sporange, which is two-valved and contains a *columella* (fig. 24, p. 55). In TARGIONIA and some others the capsule is almost sessile, and bursts irregularly. In RICCIA, where the archegones are imbedded in the frond, the sporange is a sessile globose body, with the calyptra adherent, never bursting regularly, but emitting the spores by decay. In SPHÆROCARPUS, also, the calyptra is permanent as a cellular sac, inside of which the sporange ripens into an indehiscent globular body, emitting the spores only by decay. In *Marchantia*, *Fegatella*, *Lunularia*, *Grimaldia*, &c., the arche-

gones are produced on fleshy receptacles elevated upon stalks, and the sporanges are formed on the under side of these receptacles (fig. 219. p. 305, figs. 330, 333, 335), which are of varied forms, &c. The sporanges on these either burst by valves (fig. 331), or by circumscissile dehiscence throw off a lid, as in *Fimbriaria* (fig. 335).

Fig. 329.

Fig. 330.

Fig. 331.

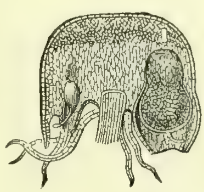


Lunularia vulgaris.

Fig. 329. Section of a receptacle, unripe.
Fig. 330. More advanced sporange, emerged from the epigone.
Fig. 331. A burst sporange.
Magnified 20 diameters.

Fig. 332.

Fig. 333.



Grimaldia barbifrons.

Fig. 332. Fertile plant. Magn. 2 diams.
Fig. 333. Section of the receptacle, with an abortive archegone on the left side, and a half-ripe sporange still enclosed in the epigone on the right. Magn. 20 diams.

Fig. 334.

Fig. 335.

Fimbriaria tenella.

Fig. 334. Receptacles with closed epigones. Magn. 10 diams.
Fig. 335. Two perigones, one with the epigone closed, the other with the teeth of the epigone open, showing the bursting sporange. Magn. 20 diams.

The frondose forms do not all produce *elaters*, and have not all the spiral fibres in the cells of their walls. The exceptions are the Riccieæ, and the elaters of *Anthoceros* are rudimentary. In *Marchantia* the elaters are highly developed (Pl. 32. figs. 36, 37), also the spiral tissue of the valves of the capsules (Pl. 32. fig. 35). TARGIONIA has branched elaters.

The spores mostly have a double coat, but not always (*e. g. Marchantia*); they germinate by protruding a pouch-like process, which becomes a filament, from which the new fronds or leafy stems arise.

The peculiarities of the different groups above referred to will be better understood after reading the following characters.

Synopsis of the Families.

A. Vegetation frondose, *i. e.* leaf and stem confounded.

1. ANTHOCEROTEÆ. The vegetative portion consists of a minute green membranous or slightly fleshy body growing on damp ground, not exhibiting any distinct midnerve; it is at once known by its peculiar fruits or sporanges, consisting of slender stalk-like bodies springing up irregularly from the upper surface of the frond, which forms little sheaths (*vaginules*) around their bases. These stalk-like fruits burst when ripe, splitting down the middle from the tip, and display a central bristle-like column (*columella*), to which adhere the minute hair-like bodies (rudimentary elaters) which are mingled with the spores.

2. MARCHANTIEÆ. The vegetative portion is here also a succulent leaf-like expansion, mostly exhibiting a more or less lobed form, and without any conspicuous midnerves in the lobes. The fruits are more complicated structures than those of Anthoceroteæ. From notches in the lobed frond arise slender stalks terminating at the top in an expanded structure (*receptacle*), resembling in some cases a conical cap, in others a star with a number of thick rays like the spokes of a wheel, &c. The spores are formed in membranous sacs attached on the under surface of the cap or star-like body, and they are *accompanied by elaters* of considerable size exhibiting highly developed spiral bands. The sporanges have *no*

columella, and burst at the tip with more or less regular tooth-like valves.

3. Riccieæ. Vegetative portion an exceedingly delicate cellular leaf-like structure, more or less lobed, with an evident mid-nerve. The sporanges are either imbedded in the substance of the frond, or only elevated on a very short stalk, and surrounded by a membranous sheath derived from the upper surface of the frond. The sporanges have *no columella* and *no elaters*.

4. Pellieæ. Vegetative portion a leaf-like frond, mostly with an evident *mid-nerve*, from *which arise the sporanges*, consisting of capsules, usually bursting by four valves, more or less elevated on a thread-like stalk. Sporange without a columella; spores accompanied by elaters.

B. Vegetation foliaceous, *i. e.* leaves and stem distinct.

5. Jungermannieæ. Vegetative portion a thread-like stem clothed with green membranous leaves more or less overlapping at their bases. *Sporanges springing from the end of the stem*, raised on more or less evident stalks, bursting by four valves and spreading in the form of a cross; spores with elaters, which often adhere to the valves of the sporange. The leafy stem of Jungermannieæ is generally readily distinguishable from that of the Mosses by the mode of insertion of the leaves, which produces a peculiar flattened arrangement.

Bibl. Hooker, *British Jungermanniæ*, 1816; G. W. Bischoff, *Bemerk. üb. die Lebermoose, Nova Acta*, xvii. p. 909, pls. 67–71, 1835; *Bemerk. zur Entwickl. der Lebermoose, Bot. Zeit.* xi. 113, *Ann. d. Sc. Nat.* 3 sér. xx. 57; Lindenberg, *Monogr. d. Riccien, Nov. Acta*, 1836, *Synops. Hepatic.* 1844; Nees von Esenbeck, *Europ. Lebermoose*, 1836; Ekart, *Synops. Jungerm.* 1832; Grœnland, *Ann. d. Sc. Nat.* 4 sér. i. 5; Hofmeister, *Vergl. Untersuch. üb. Kryptog. &c.*, Leipsic, 1851; Gottsche, *Bot. Zeitung, Suppl.* vi. 1858.

HERCOTHE'CA, Ehr.—A genus of fossil Diatomaceæ.

H. mammillaris (Pl. 43. fig. 31), the only British species; diameter 1–810″. Bermuda.

Bibl. Ehrenberg, *Ber. d. Berl. Akad.* 1844, p. 262; Kützing, *Sp. Alg.* 27.

HERPE'TIUM, Nees.—A genus of Jungermannieæ (leafy Hepaticæ), distinguished by the incubous bilobed leaves not being folded together, and by the obtusely three-angled perigone. Two Brit. species:

H. reptans (*Lepidozia*, Dumortier). Leaves squarish, acutely two- or four-toothed at the end. Woods and shady places. *Jungermannia reptans, Hook. Brit. Jungerm.* pl. 75.

H. trilobatum (*Mastigobryum*, Nees). Leaves ovate, three-toothed at the summit. Moist alpine spots. *J. trilobatum, Hook. Brit. Jung.* pl. 76.

Bibl. Hooker, *Brit. Jung. l. c.*; Endlicher, *Gen. Plant.* nos. 472–9; Ekart, *Syn. Jung.* pl. 3. figs. 21, 22.

HETEROCORDY'LE, Allm.—A genus of Hydroid Polypi, fam. Atractylidæ.

H. Conybearei. On old shells; marine. Ireland.

Bibl. Allman, *Ann. N. H.* 1864, xiv. p. 59; Hincks, *Brit. Zooph.* p. 107.

HETERODES'MUS, Brady.—A genus of recent Ostracode Entomostraca, family Cypridinidæ; subglobose, with the hinges of the valves developed into large processes at the dorsal angles.

H. Adamsii. Sea of Japan.

Bibl. Brady, *Zool. Trans.* v. p. 387.

HETERODIC'TYON, Grev.—A genus of Diatomaceæ.

Char. Fr. free, disciform; disk with radiate or scattered puncta in the middle portion, and a ring of large intra-marginal cellules.

H. Rylandsianum and *H. splendidum.* Barbadoes deposit.

Bibl. Grev. *Mic. Tr.* 1863, iii. p. 66 (fig.).

HETERO'MITA, Duj.—A genus of Infusoria, of the family Monadina.

Char. Body globular, ovoid, or oblong, with two filaments arising from the same point in front—one, more delicate, and with an undulatory motion, causing progression; the other thicker, and floating freely behind, or adhering here and there to the slide, so as to produce by its contraction sudden motion backwards.

Distinguished from *Anisonema* and *Heteronema* by the absence of a tegument, shown by the glutinous appearance of the body, the facility with which it adheres to other objects and becomes drawn out, and the presence internally of certain corpuscles which can only have entered by vacuolæ formed on the surface.

Found in both fresh and salt water.

H. ovata=*Bodo grandis*, E. (Pl. 23. fig. 18*a*).

H. granulosa. Body globular, surface granular; marine; length 1-2300″.

H. angusta. Body lanceolate, slightly sigmoid; aquatic; length 1-980″.

BIBL. Dujardin, *Infus.* p. 297.

HETERONE'MA, Duj.—A genus of Infusoria, of the family Euglenia.

Char. Form variable, oblong, irregularly expanded posteriorly; with a slender flagelliform filament, and a thicker trailing, retracting filament.

Tegument obliquely striated.

Differs from *Heteromita* in the presence of a tegument, and from *Anisonema* in the tegument being contractile.

H. marina (Pl. 24. fig. 17). Filaments longer than the body; length 1-4300″.

BIBL. Dujardin, *Infus.* p. 370.

HETERO'PHRYS, Archer.—A genus of freshwater Rhizopoda.

2 species.

BIBL. Archer, *Qu. Mic. Journ.* 1869, ix. p. 267 (figs.).

HETEROSTEGI'NA, D'Orb.—A flat, discoidal, Nummuline Foraminifer, with whorls rapidly increasing in breadth and reticulated by the primary and secondary septa of the narrow curved chambers and their rectangular partitions. Living in the Eastern Archipelago; fossil in the Tertiary beds, especially forming one stratum in the island of Malta.

BIBL. Carpenter, *Introd. For.* 288; Jones, *Geol. Mag.* ii. 151.

HETEROSTOMEL'LA, Reuss.—One of the Textilarian Foraminifera, in which the chambers are at first set on alternately, but not neatly, on either side of a straight axis, and afterwards, growing in a single row, as in *Bigenerina*, not only open terminally, instead of laterally, but have a tubular, and even a lipped, aperture, such as we see in *Uvigerina.* Shell often prickly. Fossil in the Chalk of Europe and America.

BIBL. Reuss, *Sitz. Ak. Wien,* lii.; Parker and Jones, *Ann. N. H.* ser. 4. ix. 298.

HEWAR'DIA, Hook.—A genus of Adianteæ (Polypodioid Ferns).

HEXAM'ITA, Duj.—A genus of Infusoria, belonging to the family Monadina.

Char. Body oblong, rounded in front, constricted and bifid or indented behind; two or four flagelliform filaments arising separately from the anterior margin, the two posterior lobes being prolonged into flexuous filaments.

H. nodulosa (Pl. 24. fig. 20). Oblong, with three or four longitudinal rows of nodules; motion vacillating; length 1-1800″. In decomposing marsh-water.

H. inflata.

H. intestinalis. Fusiform, prolonged into a bifid tail; length 1-2100″. In the intestines and peritoneal cavity of the Batrachia and Tritons.

BIBL. Dujardin, *Infus.* p. 296.

HILDENBRAND'TIA, Zanardini.—A genus of Nulliporous Corallinaceæ (Florideous Algæ), containing one British species, *H. sanguinea,* Kütz.: common, in the form of a bright or dark red membranous crust, at first circular, afterwards spreading irregularly over smooth stones and pebbles. The frond is about 1-20″ thick in the middle and thinner toward the edges, and composed of minute globose cells, partly vertically, partly horizontally arranged. It is not stony. It has immersed conceptacles, pierced by a pore (fig. 250. p. 314), containing *tetraspores* and paraphyses.

BIBL. Harvey, *Brit. Mar. Alg.* p. 110, pl. 14 C; *Phyc. Brit.* pl. 250; *Ann. N. H.* xiv. pl. 2 (as *Rhododermis Drummondii*); Kütz. *Phyc. gen.* pl. 78. fig. 5.

HI'LUM.—This name is applied to the surface of attachment of the *funiculus* of seeds, which is seen as a kind of scar, more or less distinct. Sometimes it coincides with the chalaza or organic base of the seed, sometimes, where a raphe exists, it is near the micropyle. (See OVULE.)

HIMANTHA'LIA, Lyngbye.—A genus of Fucaceæ (Fucoid Algæ), remarkable for the peculiar forms of the frond and receptacle, the latter consisting of a repeatedly forked strap-shaped cord from 2 to 10′ long, springing from the top-shaped frond, which is about an inch high. The dark olive-green thong-like *H. lorea* is common on rocky sea-shores. The receptacle is pierced by numerous pores leading to immersed *conceptacles* resembling those of FUCUS, containing either parietal spore-sacs or antheridia, the plants being diœcious. The centre of the receptacle is filled with mucous matter traversed by jointed filaments. The antheridial sacs of *Himanthalia* are double, and contain spermatozoids of flattened ovoid or spherical forms, with an orange granule and two cilia, like those of *Pycnophycus* and *Halidrys.*

BIBL. Harvey, *Mar. Alg.* p. 20, pl. 2 B; Thuret, *Ann. d. Sc. Nat.* 3 sér. xvi. p. 54 *et seq.*; Greville, *Alg. Brit.* pl. 3; *Engl. Bot.* pl. 569.

HIMANTID'IUM, Ehr.—A genus of Diatomaceæ, cohort Eunotiæ.

Char. Frustules resembling those of *Eunotia*, connected by their sides into a filament; striæ transverse, parallel. Aquatic.

Kützing describes thirteen species, some of which are fossil; Smith admits eight British species, one doubtful.

H. pectinale (*Fragilaria pect.*, Ralfs) (Pl. 12. fig. 36). Frustules in side view narrowed at the curved and rounded ends; one side slightly raised and flat, the other slightly excavated or flat; striæ evident; length 1-180″.

β. Convex margin undulate or with two indentations (fig. 36 *b*) = *H. undulatum*, Sm. Ralfs remarks a difference of form between the newly-forming and the parent frustules, the lateral margins of the former in front view being rounded (fig. 36*c*).

H. arcus. Fr. rectangular; valves linear-arcuate, ends rounded, subrecurved; striæ evident; length 1-300 to 1-132″.

Bibl. Ehrenberg, *Berl. Ber.* 1840; Kützing, *Bacill.* p. 36; *Sp. Alg.* p. 8; Ralfs, *Ann. N. H.* xii. p. 107, xiii. p. 459; Smith, *Brit. Diat.* ii. 10.

HIMANTOPH'ORUS, Fabricius.—A genus of Infusoria, of the family Euplota.

Char. Head not distinct from the body; hooks numerous; neither styles nor teeth present.

Long curved hooks, almost in pairs, form a broad band on the ventral surface, and are the organs of locomotion; also a row of cilia extending from the mouth a considerable distance backwards.

H. Charon (Pl. 24. fig. 18, under view; fig. 19, side view). Body hyaline, plane, elliptical, anterior end somewhat obliquely truncate; cilia small, hooks slender and long. Marine. Length 1-180″.

Bibl. Ehrenberg, *Infus.* p. 375.

HIPPAR'CHIA, Fabr.—A genus of Lepidopterous Insects.

Char. Wings more or less rounded, middle longitudinal nerve of fore wings giving off posteriorly four nerves; antennæ with an elongate, compressed and curved club; head small.

H. Janira, the meadow brown butterfly, in which the wings are brown, and the anterior pair exhibit a blackish-brown round spot with a white eye or centre, is common in meadows. The scales (Pl. 1. fig. 9) are sometimes used as Test-objects.

Bibl. Westwood, *Introd. &c.*, and *Br. Butterflies.*

HIPPOCRE'PIA.—An order of Polyzoa. Distinguished by the crescentic or horseshoe-shape of the tentacular disk, and the presence of an epistome. Aquatic.

Synopsis of the Families.

Cristatellidæ. Polype-mass floating.

Plumatellidæ. Polype-mass rooted, unjointed.

The family Paludicellidæ, containing the single genus *Paludicella*, is usually placed here; but it properly belongs to the Infundibulata, as the tentacular disk is circular and entire, and the epistome absent.

See Polyzoa and Urnatella.

HIPPOCREPI'NA, Parker.—A Lituoline Foraminifer, characterized by the horseshoe-shape of the aperture, due to the presence of a tongue-like process, as in *Valvulina*. *H. indivisa*, from the Gulf of St. Lawrence, is carrot-shaped.

Bibl. Parker, in Dawson, *Canad. Nat.* 1870.

HIPPOTH'OA, Lamx.—A genus of Infundibulate Cheilostomatous Polyzoa, of the family Eucratiadæ (Scrupariadæ).

Distinguished by the confervoid, branched, creeping and adherent polypidom, the branches arising from the sides of the elliptical cells, frequently anastomosing, and the cells in one row.

Two British species:

H. catenularia. Cells contiguous, orifices oval. On shells in deep water.

H. divaricata. Cells remote, orifices round.

Bibl. Johnston, *Brit. Zooph.* 291; Gosse, *Mar. Zool.* 12.

HIPPURIC ACID.—This acid occurs in small quantity in human urine, especially after a vegetable diet; more largely in that of the horse and other herbivora, as the ox, the goat, the sheep, the hare, &c.; also in that of some reptiles.

It is readily soluble in boiling water and alcohol; less so in cold water and in ether.

It crystallizes in prisms or needles (Pl. 7. fig. 18), belonging to the right rhombic prismatic system, some of which bear resemblance to those of the ammonio-phosphate of magnesia, from which it is readily distinguished by its solubility in potash or hot water. It is sometimes obtained under the same circumstances as benzoic acid, from which it differs in its greater solubility in ether, and in the thickness and solidity of its prisms, those of benzoic acid being thin and plate-like. Its crystals are beautifully analytic; which property is deficient in those of benzoic acid.

It may best be procured from cow's urine,

by boiling with slaked lime for some time, filtering and supersaturating with muriatic acid; and it may be purified by repeating the process and using animal charcoal.

BIBL. See CHEMISTRY.

HIRNE'OLA, Fr.—A genus of Tremellini (Hymenomycetous Fungi), consisting of gelatinous cup-shaped Fungi, horny when dry, and clothed externally with short velvety bristles. The hymenium is without papillæ, a character by which it is distinguished from *Exidia*, to which the species were formerly referred. The Jews' Ear (*H. auricula Judæ*) is still sold by Herbalists as a remedy for affections of the throat, the supposed virtues clearly depending on the doctrine of signatures. One or two species are extremely common in tropical countries.

BIBL. *Fr. Summa*, p. 340; Berk. *Outl.* p. 289.

HISTOLOGICAL ANALYSIS. See INTRODUCTION, p. xxxviii.

HISTOLOGY, or HISTIOLOGY, is the theory of the structure of animal and vegetable tissues in relation to their development.

HOLOPH'RYA, Ehr.—A genus of Infusoria, of the family Enchelia.

Char. Body covered with vibratile cilia, oblong-ovate, cylindrical or globular, rounded or truncate in front; no lips nor teeth.

Cilia arranged in longitudinal rows.

Ehrenberg admits five aquatic species; to these Dujardin, who places this genus in the family Paramecia, adds one marine.

H. ovum, E. (Pl. 24. fig. 22). Body ovate, subcylindrical, ends subtruncate; internal substance green; length 1-576 to 1-216″.

H. brunnea, D. (Pl. 24. fig. 21). Body brown, cylindrical, becoming globular when distended with food and then changing in colour; length 1-120″.

The encysting-process has been observed in two of the species.

BIBL. Ehrenberg, *Infus.* p. 314; Dujardin, *Infus.* p. 493; Cohn, *Sieb. and Köll. Zeitschr.* iv.; Stein, *Infus.*

HOLOTHURID'EA (Sea-slugs).—A family of Echinodermata, of the order Pedicellata.

Interesting to the microscopist, from the presence of curious calcareous plates, &c. existing in the integument.

See ECHINODERMATA.

HOLO'THYRUS, Gerv.—A genus of Arachnida, of the order Acarina and family Gamasea.

H. coccinella is nearly as large as a lady-bird (*Coccinella*), and is found in the Isle of France.

BIBL. Gervais, *Walckenaer's Aptères*, iii.

HOMŒOCLA'DIA, Ag.—A genus of Diatomaceæ.

Char. Frustules those of *Nitzschia*, arranged in tufts within gelatinous tubes, which form a filiform, usually branched frond. Marine.

Kützing supposes the existence of median and terminal apertures (nodules), and places the genus in the same family as *Navicula*, &c.; but these are not represented in his figures, neither are they mentioned by Ralfs. Smith pointed out the true structure of the valves.

H. Martiana, Ktz. (*H. anglica*, Ralfs) (Pl. 14. fig. 15: *a*, portion of frond; *b*, part of a filament containing two frustules; *c*, front view of single frustules, with endochrome; *d*, side view of empty frustule). Frond simple or dichotomously divided, rugose; entire plant 1 to 2″ high.

H. filiformis. Frond linear, simple, tufts containing three or four frustules.

H. sigmoidea. Frond linear, simple; frustules sigmoid.

Rabenhorst describes 8 European species.

BIBL. Kützing, *Bacillar.* p. 110, and *Sp. Alg.* 97; Ralfs, *Ann. N. H.* 1845, xvi. 109; Smith, *Brit. Diat.* ii. 80; Rabenhorst, *Fl. Alg.* i. p. 166.

HOOF.—The hoofs of animals consist of the same structure as horn.

HOOKE'RIA, Smith.—A genus of Hypnoid Mosses.

BIBL. Wilson, *Bryol. Brit.* p. 415.

HOP.—The hop plant (*Humulus Lupulus*) is remarkable for the glands containing the resinous secretion imparting the aromatic odour. These occur upon the lower face of the leaf, upon the calyx, and, above all, on the scales of the fruit and the seed-coat. They have been examined by Meyen and others, most recently by Personne. They are little stalked cups (Pl. 21. fig. 14) composed of a single layer of cellular tissue, concave above at first; but as the secretion increases in quantity, the cuticle becomes detached in a plate from the upper surface, except at the rim of the cup, and is pushed up so as finally to form a convex papilla on the top, like the nut projecting from an acorn-cup. The secretion appears to be formed in the cells, and poured out beneath the cuticular pellicle, which is marked with lines corresponding to the side-walls of the

cells. Solution of potash and alcohol clean away the resinous secretion, and render the structure clear. When the fresh glands are placed in water, they swell, and finally burst, the cuticular lid usually separating by a circumscissile dehiscence.

The hop is subject to a peculiar mildew, a minute fungus, for which see ERYSIPHE (*Sphærotheca*).

BIBL. Meyen, *Secretions-Organe d. Pflanzen*, p. 38, pl. 5. figs. 17–21; Personne, *Ann. d. Sc. N.* 4 sér. i. p. 299, pl. 17.

HOPLOPH'ORA, Koch.—A genus of Arachnida, of the order Acarina and family Oribatea.

Char. Body and general habit those of *Galumna*, but no wing-like appendages to the pseudo-thorax.

Two species; not British (?).

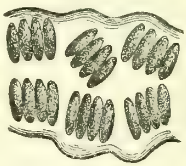
BIBL. Koch, *Deutschl. Crustac. &c.*; Gervais, *Walckenaer's Aptères*, iii.

HORMID'IUM.—The group of terrestrial species of *Ulothrix*.

HORMOS'PORA, Brébisson.—A genus of Palmellaceæ (Confervoid Algæ), with a

Fig. 336.

Fig. 337.



Hormospora transversalis.

Fragments of gelatinous filaments, with the cells grouped in fours.

Magnified 350 diameters.

frond consisting of simple or branched gelatinous confervoid cords enclosing rows of oval or spherical cells; they are found floating among Confervæ or other aquatic plants, and appear to the naked eye like greenish filaments. These plants do not appear to consist of septate filamentous tubes like the Confervæ, but of rows of individual cells imbedded in a filiform gelatinous tube (fig. 336), analogous in its nature to the gelatinous coat investing the linear rows of cells of *Hyalotheca*, &c. The cells multiply by transverse division, the rows thus becoming elongated; these cells contain green contents arranged in a granular, lamellar, or radiating form. Brébisson describes obscurely another mode of increase, in which the "endochrome becomes concentrated and organized into vesicles or zoospores. The corpuscles then become larger; and the filament becoming as it were dislocated, the corpuscles group themselves in several rows, and without regular form" (fig. 337). In *H. transversalis* there is an especial tendency to a grouping of the cells in fours. Five species have been described; 1 and 3 are known as British.

H. mutabilis, Bréb. Filaments simple; cells ovoid or subspherical; cell-contents lamellar. Aquatic. Bréb. *Ann. d. Sc. Nat.* 3 sér. i. pl. 1. fig. 1.

H. transversalis, Bréb. (figs. 336, 337). Filaments simple; cells ovoid or fusiform, transverse; contents granular. Aquatic. Bréb. *l. c.* fig. 2.

H. ramosa, Thwaites. Filaments branched; cells oval or spherical; contents radiated. In a pool to which salt water had access. Harvey, *Phyc. Brit.* pl. 213.

BIBL. Brébisson, *Ann. d. Sc. Nat.* 3 sér. i.; Harvey, *Brit. Mar. Alg.* p. 235, pl. 27 B, *Phyc. Brit.* pl. 213; Nägeli, *Einzell. Alg.* p. 7, pl. 3. fig. B; Rabenhorst, *Fl. Alg.* iii. p. 48.

HORN.—The horns of animals are of three kinds,—those composed of bone, those consisting of epidermic formations, and those in which both are present. The former, properly called antlers, agree in minute structure with bone, and therefore require no special notice. The horn of the rhinoceros may be taken to represent the structure of the second kind. It consists of an aggregation of horny fibres, each of which is made up of a series of concentric layers. These layers are composed of cells tangentially flattened, and sometimes containing pigment. The cells may be separated by macerating the horn in solution of potash. Cracks filled with air are frequently visible between the layers. The centres around which the laminæ are arranged probably correspond to papillæ of the cutis.

The horn of the buffalo agrees essentially in structure with that of the rhinoceros.

The third kind of horn is exemplified by that of the cow. In its centre is a process of bone, surrounding and extending beyond which is the proper horn, consisting of concentric layers, in the natural state composed of flattened, irregular, angular, nucleated cells (Pl. 17. fig. 29 *a*), which assume their primitive forms under the action of potash (*b*); some of them contain pigment (*d*). Between the laminæ, cracks containing air are also met with (*f*).

Sections of horn made at various angles to

the axis, form very beautiful polarizing objects; the gorgeous colours seen in those of rhinoceros's horn cannot be excelled, nor can drawings represent them faithfully (Pl. 31. figs. 37, 38). The horn of the buffalo also forms an interesting object of the same kind.

BIBL. Donders, *Mulder's Phys. Chem.*; Owen, *Brande's Dict.*, art. *Cornua.*

HORSE-LEECH. See HÆMOPIS.

HUXLEY'A, Cl. & Lachm.—A genus of Infusoria, of the family Ervilina. Two species:

H. sulcata. Body greatly compressed; cuticle with oblique furrows. Bergen.

H. crassa. Body scarcely compressed, almost as thick as broad, thickest behind; cuticle smooth; length 1-1250″. Bergen.

BIBL. Clap. & Lachmann, *Infus.* p. 290.

HYALODIS'CUS, Ehr. = CYCLOTELLA, Kütz. in part.

H. lævis = Cyclotella lævis.

H. patagonica = Cycl. patagon.

BIBL. Ehrenberg, *Berl. Ber.* 1845, pp. 78 & 155; Kützing, *Sp. Alg.* p. 20.

HYALOSI'RA, Kütz.—A genus of Diatomaceæ.

Char. Frustules compound, rectangular, tabular; with alternate vittæ, interrupted in the middle, and connected with those of the opposite side by fine lines; lowermost frustule attached by a stipes which is affixed to one angle. Marine.

The fine lines at the end of the vittæ give the latter a forked appearance. The frustules are often partly separated, so as to be connected with each other by one angle only.

Four species, probably forms of *Tetracyclus.*

H. rectangula (Pl. 13. fig. 1). Stipes short, frustules subconcatenate, in front view subquadrate; rectangular; length 1-1380″.

BIBL. Kützing, *Bacillar.* p. 125; *Sp. Alg.* p. 115; Rabenhorst, *Fl. Alg.* i. p. 306.

HYALOTHE'CA, Ehr.—A genus of Desmidiaceæ.

Char. Cells united into an elongated, cylindrical filament, which is surrounded by a gelatinous sheath; cells in front view slightly constricted, so as to give the margins a crenate appearance; or having a grooved rim surrounding one end, and forming a bidentate projection; end view orbicular.

The filaments are not twisted, and are always of the same apparent breadth. Sporangia orbicular, smooth.

H. dissiliens (Pl. 10. fig. 1, front view of filament; 2, end view). Filament fragile, margins crenate; breadth of filament 1-1300 to 1-800″. The transparent sheath of this beautiful object is so delicate as to be easily overlooked. Sporangia (fig. 314) situated within the connecting tube.

Not uncommon in clear boggy pools.

H. mucosa. Filament scarcely fragile; joints not constricted, surrounded at one end by a minute furrowed rim, forming in the front view a bidentate projection; breadth of filament 1-1250 to 1-1100″.

The furrowed rim of each cell is on the same side as that of the contiguous cell.

BIBL. Ralfs, *Brit. Desmid.* p. 51.

HYDATI'NA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes absent; jaws two, teeth numerous, free; foot forked.

H. senta (Pl. 34. fig. 37; fig. 38, teeth). Body conical, hyaline; margin of rotatory organ ciliated; foot robust; aquatic; length 1-48 to 1-36″.

This animal forms a favourable subject for the examination of the typical structure of the Rotatoria, and is that which Ehrenberg used as the basis of his investigations upon their organization.

H. brachydactyla. Segments of foot short; body suddenly narrowed at the base of the foot; aquatic; length 1-144″.

BIBL. Ehrenberg, *Infus.* p. 412; Cohn, *Sieb. & Köll. Zeitschr.* vii.

HYDATINÆ'A.—A family of Rotatoria.

Char. Neither carapace nor enveloping sheath present; rotatory organ multiple, or more than bipartite.

18 genera.

Eyes absent,	
No teeth	*Enteroplea.*
Teeth present,	
Jaws with numerous teeth	*Hydatina.*
„ with a single tooth	*Pleurotrocha.*
Eyes present,	
Eye single,	
Eye frontal	*Furcularia.*
„ cervical,	
Foot styliform	*Monocerca.*
„ forked,	
Frontal cilia, no hooks nor styles	*Notommata.*
Frontal cilia, styles present	*Synchæta.*
„ hooks	*Scaridium.*
Foot absent; with cirrhi or fins.	*Polyarthra.*
Eyes two,	
Eyes frontal,	
Foot forked	*Diglena.*
„ styliform,	
With cirrhi	*Triarthra.*
Without cirrhi	*Rattulus.*
Eyes cervical	*Distemma.*
Eyes three,	
Eyes not stalked,	
Eyes cervical	*Triophthalmus.*
Two eyes frontal, one cervical.	*Eosphora.*

Two frontal eyes stalked, one cervical not stalked	*Otoglena.*
Eyes more than three in a single group	*Cycloglena.*
Eyes more than three in two groups	*Theorus.*

BIBL. Ehrenberg, *Infus.* p. 410.

HYD'NEI.—A family of Hymenomycetous Fungi, characterized by bearing their basidiospores on tubercles or spine-like processes on the under side of a discoid, cup-shaped or funnel-shaped, stalked or sessile *pileus.* The basidiospores are seen by making cross sections of the spines, &c. See BASIDIOSPORES, HYMENOMYCETES.

BIBL. Berkeley, *Ann. N. H.* i. 81; Leveillé, *Ann. d. Sc. N.* 2 sér. viii. 32.

HYDNOGLŒ'A, Berk. & Curr.—A genus of Tremelloid Fungi, consisting of *Hydnum gelatinosum*, and one or two other species, which agree in structure with *Tremella* rather than *Hydnum*, so that it can only be considered as analogous rather than allied to *Hydnum*. *H. gelatinosa* occurs in this country occasionally on very rotten pine wood.

BIBL. Berk. & Br. *Ann. N. H.* 1871, vol. vii. p. 429.

HY'DRA, Linn. (Freshwater Polype).—A genus of Hydroid Polypi, of the family Hydridæ.

Char. Locomotive, single, naked, gelatinous, subcylindrical, but very contractile and variable in form; the mouth surrounded by a single row of filiform tentacles. Propagation by the formation of gemmæ, and ova upon or within the substance of the body of the animal.

Hydra viridis (Pl. 33. fig. 21, adhering to the radicles of duck-weed (*Lemna*)). Body leaf-green, cylindrical or insensibly narrowed towards the base; tentacles 6 to 10, shorter than the body.

Common in ponds and still waters. Tentacles narrowest at their origin.

H. vulgaris. Body orange-brown, yellowish or red, cylindrical; tentacles 7 to 12, as long as or longer than the body.

Tentacles tapering to the free ends.

Found in weedy ponds and slowly running waters; common.

H. attenuata. Body pale olive-green, attenuated below; tentacles pale, considerably longer than the body.

In ponds; rare.

H. fusca (*oligactis*). Body brown or greyish, lower half suddenly attenuated; tentacles 6 to 8, several times longer than the body.

Still waters; rare.

The characteristic forms of the body can only be judged of when fully extended in search of prey; for when the animals are touched, shaken, or in any way disturbed, the body assumes very variable forms, becoming rounded, ovoid, &c.

The structure of the body of *Hydra* has been much investigated and discussed. By some it has been regarded as consisting of three layers—an internal and external coat, and an intermediate muscular layer. The true structure, however, has been pointed out by Ecker. This author correctly regards the animal as consisting of the substance denominated sarcode by Dujardin, and neither furnished with an outer nor an inner coat. The transparent, gelatinous, sarcodic substance forms the entire mass of the body and tentacles; on the surface it is frequently irregularly rounded or nodular, or exhibits spiral or other raised lines (Pl. 33. fig. 23 *b*); and it contains numerous vacuoles within. If a *Hydra* be crushed between glasses, portions of the sarcode will be separated, and assume a globular form, closely resembling that of cells; the vacuoles will also become greatly distended, just as occurs in the substance of the Infusoria; and these separated portions will often continue contracting like an *Amœba.* Two of them are represented in Pl. 33. fig. 29; in *a*, a rather small vacuole is present, whilst in *b* this is very large. Now in the latter instance the globule, as regards structure, forms a true cell, consisting of a closed sac, with liquid contents. Physiologically speaking, however, it does not correspond to a cell, the entire substance representing cell-contents around which a cell-wall has never been formed. A number of these vacuoles exist naturally, diffused throughout the substance of the body. The intermediate stratum, which is not organically distinct, contains imbedded in it a number of very minute green or otherwise coloured granules; these are of a rounded form, and present a double outline, as if composed of cells. In the uninjured *Hydra* they exist in the intervacuolar substance, thus giving the tissue an elegantly reticular appearance. They appear to consist of chlorophyll; they are insoluble in potash; they become coloured purplish red-brown by iodine and sulphuric acid, after treatment with potash; and the green granules of *Hydra vulgaris* are rendered bluish green by sulphuric acid, in the same manner as the chlorophyll

of leaves. The colour of *Hydra* has been differently accounted for. Laurent states that he succeeded in colouring them blue, white, and red, by feeding them with indigo, chalk, and carmine,—whilst Hancock has shown that the colouring is much affected by exposure to light—those not exposed to light, from living under stones, &c., having the natural colour, whilst those exposed to the light became bleached. It is generally admitted, however, that the colour depends upon or is modified by the nature of the food; but exact experiments are wanting to decide the question. Towards the inner surface of the body, the granules are brownish or blackish.

Imbedded in the superficial portions of the substance of the *Hydra* are certain curious bodies, termed the stinging organs (Pl. 33. fig. 23 *a*). These are best seen upon the tentacles; they consist of an oval, truncate, firm capsule (Pl. 33. fig. 22 *b*) of comparatively considerable thickness, as indicated by its marked double outline. Within the capsule is contained a very long and slender filament, at the base of which are four minute spines. In the undisturbed state of the *Hydra*, the filament with the spines is coiled up in the capsule (fig. 22 *a*); but when the animal is touched, pressed, or heated, the filament with the spines flies out with extraordinary rapidity, so that we have not been able to determine exactly how the spines are arranged within the capsule. Most probably the spines, while within the capsule, are directed forwards and in close contact, and then, in assuming their recurved position, they are the means of projecting the filament forwards. A capsule, containing an unexpanded filament and spines enclosed within a detached globule of sarcode, is represented in fig. 22 *d*. When these capsules are heated with a solution of nitrate of silver, a portion of the silver is reduced to the metallic state. This action is a property of formic acid; hence, when it is considered that these organs closely resemble in structure those of the Acalephæ, which possess an urticating power like stinging-nettles, arising from the presence of formic acid, and that in *Hydra* these filaments are driven into and wound the prey, it may appear probable that they secrete and contain formic acid. But, as many other substances reduce salts of silver, and as the sarcode, from which it is perhaps impossible to separate these bodies, may produce this effect, the point must be considered doubtful and requiring further investigation. In addition to these stinging organs, we have found other very minute capsules (fig. 22 *c*), containing a filament curved even when emitted, the nature of which is obscure.

A third kind of organ is said to have been met with also in the surface of the body, consisting of ovate capsules or bodies, from which a stout and short filament projects. These appear to resemble the organs of adhesion of the Acalephæ; but as their size is not stated, nor the diameters of the figures expressed, we have been unable to identify them.

The body and tentacles of *Hydra* are hollow. The prey, which consists of Entomostraca, small Annulata, &c., when caught by one or more of the tentacles extended for the purpose, is slowly brought to the mouth, and forced into the cavity of the body, in which it is digested; the undigested portions being evacuated through the mouth. It is still a question whether a posterior outlet to the cavity of the body exists. The posterior part of the body is more or less dilated into a flattened disk, which, by its suctorial power, enables the animal to attach itself to various bodies. Hancock has seen excrementitious matter passing through the body at this part and the disk; but most, if not all, previous observers have denied the existence of a canal. The cavities of the tentacles have been described as containing a semifluid substance, undergoing a kind of circulation; and those of both the tentacles and the body have been stated to be lined with cilia.

The extraordinary power which *Hydra* possesses of reproducing lost parts is truly wonderful. Thus, if the body be cut into two or more, even into forty parts, each portion continues to live, and develops a perfect new animal. If the section be made lengthwise, so as to divide the body all but the end, the two portions become resoldered and form a perfect being; if the pieces be kept asunder, each becomes a *Hydra*, the two possessing but one posterior end; if the section be made from the tail towards the head, the two bodies will be perfected and remain attached to the one head. If a tentacle be cut off, a new animal is formed from it. When one end of the body of a *Hydra* is introduced into the body of another, the two unite and form one. The head cut off one, may be engrafted upon the body of another which wants one. And when the body is turned inside out, the outer surface, which has thus become the

inner, will perform the ordinary digestive functions, and the animal will continue to live.

The ordinary mode of reproduction of *Hydra* is by gemmation: a minute swelling forms upon some part of the surface of the body; this enlarges, and gradually assumes the form of the parent, while remaining attached to it. Sometimes several of these are formed upon a single individual at the same time, and so, remaining adherent, they give the animal a branched appearance (Pl. 33. fig. 21).

At certain seasons of the year, as at the end of summer or in the autumn, reproduction takes place by the formation of spermatozoa and ova. The spermatozoa are formed within spermatic capsules. These arise as minute conical tubercles a little beneath the base of the tentacles, one on each side (Pl. 33. fig. 24 *a*); and the spermatozoa are liberated from them by bursting. The spermatozoa in the figures resemble those of the Mammalia, except that the tails are undulate. The ova are furnished with a thick coat, and are formed in the substance of the lower part of the body (fig. 24 *b*). They subsequently separate from the body, and appear to be capable of spontaneous motion; but whether from the presence of cilia or not, is undecided. The sac of the ovum then becomes ruptured, and the new animal escapes (fig. 25).

Hydræ are very common. The best method of procuring them is to collect a number of water-plants from any clear pool or slow stream, and bring them home in an india-rubber bag (sponge-bag). On placing the plants subsequently in a glass jar (confectioners' jar) containing water, they will be found at the end of some hours with the tentacles fully extended in search of prey, when they are easily recognized. They usually adhere to the sides of the glass, or to the stems or undersides of the leaves of the plants; but sometimes they are seen suspended from the surface of the water by the sucker, which is protruded just above it so as to become partly dry. A number of small Entomostraca should be added to the water, as the *Hydræ* are very voracious.

Some of the species of *Hydra* are occasionally covered with minute parasitic Infusoria, viz. *Kerona polyporum* (Pl. 41. fig. 13), which is found upon *H. vulgaris* and *fusca*, and *Trichodina pediculus* (Pl. 24. fig. 16), which occurs upon *H. vulgaris* and *viridis*. It is an interesting sight to see these running up and down the tentacles and surface of the body of the polypes, when we recollect that their surface is covered with the stinging organs. These lice are not, however, found upon perfectly healthy polypes, impurity of the water and an unhealthy state being generally denoted by their presence.

Bibl. Leeuwenhoeck, *Phil. Tr.* 1703, xxiii.; Trembley, *Mém. s. l. Polyp. d'eau douce*; Ehrenberg, *Corall. d. roth. Meer.*; Laurent, *Rech. s. l'Hydre, &c.*; Corda, *Ann. d. Sc. Nat.* 2 sér. viii.; Schaeffer, *D. Armpolyp.*; Erdl, *Müller's Archiv*, 1841; Ecker, *Sieb. and Köll. Zeitschr.* i.; Johnston, *Brit. Zooph.*; A. Thomson, *Todd's Cycl. Anat. and Phys.* iv. p. 17; Hancock, *Ann. Nat. Hist.* 2 ser. v. p. 281; Allman, *Microsc. Journ.* 1854; Hincks, *Brit. Zooph.* p. 309.

HYDRACH'NA, Müll.—A genus of Arachnida, of the order Acarina and family Hydrachnea.

Char. Palpi tolerably long, third joint longest, the fourth and fifth terminated each by a claw; mandibles ensiform; rostrum long, scarcely shorter than the palpi; body rounded; eyes distant; vulva concealed by a plate or shield.

When young, these little water-spiders have three legs only, and in this state have formed another genus, *Achlysia*. Several species:

H. cruenta, Müll. = *H. globula*, Herm. (Pl. 2. fig. 29). Body subovate; two pairs of eyes at a moderate distance apart, reniform, dark red; skin covered with minute puncta.

The rostrum is broad and curved at the base (fig. 29 *c*, the lower part directed to the left), cleft above, so as to form a kind of channelled sheath, containing the anterior narrower portions of the two mandibles (*b*). The palpi (*c*, upper organ) are inserted upon the sides of the base of the rostrum and curved downwards; the first joint is very broad, the second much curved, the third long, and flattened on one side and rounded on the other; the fourth joint is short, and terminated by a short and thick claw; the fifth also forms a claw, but the two claws do not form a chela, their curves being parallel. Of the legs (fig. 29 *a*), the three posterior pairs are ciliated for swimming, and the posterior are much longer than the anterior; the coxæ are flattened and form two groups on each side; between the two posterior coxæ is the orifice of the reproductive organs; the tarsi all have two claws, and

are obliquely truncated and concave at the end (fig. 29 *e*).

The eggs are reddish-brown and deposited upon the stems of water-plants; the nymphæ are found attached to aquatic insects (fig. 29 *f*), as *Nepa*, *Dytiscus*, &c.

H. geographica. Body spherical, black, with spots and yellow points; palpi red, acute; legs shorter than the body, black, but red at the ends.

H. concharum. Inhabits the pallial cavity of the Naiades.

Bibl. Dugès, *Ann. des Sc. Nat.* 2 sér. i.; Gervais, *Walckenaer's Arachn.* iii.; Koch, *Deutschl. Crustac. &c.*

HYDRACH'NEA (Water-spiders).—A family of Arachnida, of the order Acarina.

Palpi with the last joint unguiculate or spinous; two or four distinct ocelli; coxæ broad, legs generally ciliated, natatory, the posterior longest.

The characters of the genera must be sought under the individual heads. See Arrenurus, Atax, Diplodontus, Eylaïs, Hydrachna, and Limnochares.

Bibl. See that of the order.

HYDRACTIN'IA, V. Bened.—A genus of Polypi, of the order Hydroida, and fam. Hydractiniidæ.

Char. Polypidom incrusting; polypes claviform, tentacles in a single whorl at the base of a conical proboscis.

H. echinata. Polypidom rough with serrated spines, whitish fleecy. On univalve shells tenanted by the hermit crab.

Bibl. Hincks, *Brit. Zooph.* p. 19.

HYDRALLMAN'IA, Hincks.—A genus of Polypi, of the order Hydroida, and fam. Sertulariidæ.

H. falcata = *Plumularia falc.* Johnst.

Bibl. Hincks, *Brit. Zooph.* p. 273.

HYDRAN'THEA, Hincks.—A genus of Hydroid Polypi, fam. Atractylidæ.

H. margaritacea, White. On *Flustra foliacea.*

Bibl. Hincks, *Ann. N. H.* 1863, xi. p. 45; and *Brit. Zooph.* p. 99.

HYDRIA'NUM, Rab.—A genus of Palmellaceous Algæ.

Char. Cells resembling those of *Characium*, but open at the ends; endochrome contracted, ultimately becoming resolved into 2–4–8 zoogonidia.

12 species: aquatic; adherent to other Algæ.

Bibl. Rabenhorst, *Fl. Alg.* iii. p. 87.

HY'DRIAS, Ehr.—A genus of Rotatoria, of the family Philodinæa.

Char. Eyes absent; neither proboscis present, nor horn-like processes on the foot; rotatory organs two, placed at the ends of two anterior processes of the body.

H. cornigera (Pl. 34. fig. 39). Body ovate, hyaline; foot narrowed into the form of a slightly forked tail; aquatic; length 1-190″.

Probably a young and imperfectly examined *Philodina.* Found in Egypt.

Bibl. Ehrenberg, *Infus.* p. 483.

HY'DRIDÆ.—A family of Polypi (Zoophytes), of the order Hydroida.

It contains the single genus *Hydra.*

HYDROCHARIDA'CEÆ.—A family of Monocotyledonous Flowering Plants growing in water, interesting to the microscopist, as affording very favourable opportunities of viewing the circulation or *rotation* of the cell-contents. The leaves of *Vallisneria spiralis*, an Italian plant, which is readily grown in jars of water indoors, are very frequently used for this purpose; the leaves and sepals of *Anacharis Alsinastrum*, a North American plant, now naturalized in streams in many parts of Britain, also show the circulation well. The extremities of the roots of *Hydrocharis morsus-ranæ*, a plant common, floating on the surface, in broad permanent ditches, are likewise adapted for the purpose. The circulation consists of the flowing movement of a layer of colourless protoplasm over the inner surface of the walls of the cells. Where, as in the leaves of *Vallisneria* and *Anacharis*, the cells contain green globules of chlorophyl, these mostly adhere to the circulating mass, and are carried round with it. The phenomenon may be observed in uninjured young leaves simply immersed in water, by focusing carefully; but in *Vallisneria* it is seen more clearly in slices taken carefully parallel to the surface of the leaf. The circulation lasts a long time in these separate fragments if they are kept wet. Sometimes it is arrested by the preparation; in such cases the application of a gentle heat often causes it to recommence. It may be observed with a power of 200 diameters; but a higher is requisite for minute investigation. (See Rotation.)

HYDROCO'LEUM, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), corresponding to aquatic species of *Chthonoblastus.*

11 European species.

Bibl. Kützing, *Phyc. Gen.* 196; Rabenhorst, *Fl. Alg.* ii. p. 149.

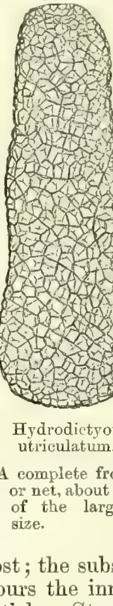
HYDROCY'TIUM, Al. Braun.—A genus

of unicellular Algæ, separated from that author's *Characium* on account of the whole contents becoming at once broken up into active gonidia, not by successive subdivisions (Pl. 45. fig. 1). Green. Found upon stones or filamentous Confervæ in fresh water, and consisting of elliptical sacs or cells, acuminate above and below, about 1-500″ long and 1-1200″ thick. 2 species.

Bibl. Al. Braun, *Alg. Unicell. Gen. Nov.* Leips. 1855, p. 24.

HYDRODIC'TYON, Roth.—A genus of Siphonaceæ (Confervoid Algæ), containing one species, *H. utriculatum*, found in freshwater pools in the midland and southern counties of England. The frond consists of a green open network of filaments attaining a length of 4 to 6″ when full-grown (fig. 338), composed of a vast number of cylindrical tubes (cells) with rounded ends, adherent together at their extremities, the points of junction corresponding to the knots or intersections of the network. The individual cells attain a length of 4‴ or more. The organization of this plant and its development are exceedingly curious; and it has lately been the subject of very careful investigation by Al. Braun and others. The cells forming the links of the net have a remarkably thick cellulose coat when full-grown, which exhibits several layers, especially when treated with sulphuric acid (Pl. 38. fig. 24 *m*). Weak sulphuric acid does not affect the outer layer, which may be termed the cuticle, while it swells the inner, and throws them into waves, especially the innermost; the subsequent addition of iodine colours the inner layers blue, but not the cuticle. Strong sulphuric acid acts differently: it detaches the cuticle at many points, while the inner layers contract, so that the cuticle appears blown up in vesicles; the inner layers gradually soften and dissolve. These last changes are similar to what takes place at the dissolution of the cell when the contents escape; and Cohn states that the membranes give the bluish reaction with iodine alone when thus partially decomposed by natural causes. The contents of the cell present several points of interest connected with the phenomena of cell-life, indicating a complexity in the organization of the internal structures not formerly suspected, but which appears to prevail pretty generally.

Fig. 338.



Hydrodictyon utriculatum.

A complete frond or net, about ¼th of the largest size.

Immediately lining the wall is a mucilaginous layer (Pl. 38. fig. 24 *b*), which Braun has shown to consist of several lamellæ:— 1. An extremely thin, finely punctate, layer, coagulated and detached from the cell-wall by the action of acids; this is the *primordial utricle* of the cell. 2. The *outer mucilaginous layer*, thicker than the primordial utricle, but thinner than the next or third layer. When separated from the first layer, the outer surface appears rough and wavy, and it is connected with the third layer by mucilaginous cords; it contains indistinctly defined colourless granules. 3. The *inner mucilaginous layer*, the thickest of the three, is rough on the outside and waved on the inside from the projection of granules imbedded in it; this is the only green layer, appearing of a homogeneous green colour (like the spiral bands of *Spirogyra*) when the cells are in their prime, besides which it contains innumerable green granules, sometimes in rows, more frequently uniformly scattered. This layer likewise contains starch-corpuscles, such as occur in the green substance of the Confervoids generally, causing the cell-contents to exhibit a vast number of brilliant points. In imperfect cells the green layer sometimes appears in patches, not completely investing the surface of the outer mucilaginous layer; this is also common in young cells. The fluid in the cavity of the cell is clear and watery.

The reproduction of the fronds of *Hydrodictyon* is effected by the conversion of the contents of the individual cells into complete new nets like the parent, which sets them free by dissolution. The following is a brief history of this remarkable process. The first stage is the solution of the starch-grains; the green layer becomes more opaque; lighter spots appear on the inner part of the mucilaginous layer, excavated in its substance and surrounded by the chlorophyl-globules, which separate from each other, forming dark boundary lines round the light spots. The bright-green then gives place to a browner tinge. The light spots already observed (the centres of the nascent gonidia), exerting an attraction as it were on the chlorophyl-globules, become severally enveloped in a layer of them, and then separate from each other, so as to

appear like dark spots with an intervening reticulation of bright lines. The dark spots (gonidia) are now polygonal, mostly six-sided, about the 1-2500″ in diameter. The parent-cell membrane next begins to soften and swell up; the gonidia, thus acquiring more space, become rounded, and soon present a slight tremulous oscillatory movement. The cuticle of the parent cell then cracks, allowing the inner softened layers to swell out; the gonidia commence an active trembling and jerking motion, not, however, moving far from one spot; after a time they again come to rest, and become united at certain points of their circumference; the green granules become fused into a homogeneous mass, and the rudiment of the first starch-granule soon appears, while the gonidia grow out into a tubular form, acquire a cellulose membrane, and collectively form a new net, which becomes free by the total solution of the parent cell. These gonidia appear to possess four short cilia; their motion lasts about half an hour; from 7000 to 20,000 occur in one cell. They are distinguished by Braun as *macrogonidia*, from other gonidia of smaller size and longer shape, which he calls *microgonidia*, furnished with four long cilia and a red parietal spot. These have a different history. From 30,000 to 100,000 appear in the parent cell, their development presenting the same characters as that of the *macrogonidia* up to the time when the motion begins. Then, the *microgonidia*, unlike the net-forming *macrogonidia*, leave their parietal positions with a whirling motion, and move through the entire cavity of the parent cell, until at length the membrane of the latter bulges out in one or more places and bursts, and the microgonidia leave the cavity in a swarm. According to Cohn, they are at first enclosed in a thin mucilaginous pellicle protruded before them [like the swarming spores of PEDIASTRUM]. However, they escape, become free in the water, and swim about for a long time. At length they come to rest, sink to the bottom, and remain there heaped in green masses, like cells of PROTOCOCCUS, for a long period. Their further history is unknown.

The rapidity of the growth of the *Hydrodictyon*-net by the above process is wonderful; the component cells of the net increase, under favourable circumstances, to 600 times their original length in a few weeks. In cultivated specimens, the whole history, from the origin of a net to the production of a new one, passes over in three or four weeks. The original size of the cells is about 1-2500″; in the fully developed condition they are about 1 to 4″ long. No development of *spores* or resting-spores has yet been observed.

BIBL. Vaucher, *Conferves*, p. 82, pl. 9; Areschoug, *Linnæa*, xvi. p. 127, pl. 5 (1842); Hassall, *Brit. Freshw. Alg.* p. 225, pl. 58; Al. Braun, *Verjüng. &c.* (*Ray Soc.* 1853); *Alg. Unicell. Sp. Nov.* Leips. 1855, p. 55; Cohn, *Nova Acta*, xxiii. 207, pl. 19; Pringsheim, *Berl. Ber.* 1860; *Qu. M. Jn.* 1862, pp. 54, 104.

HYDROGAS'TRUM, Desv. = BOTRYDIUM.

HYDROI'DA.—An order of Polypi (Zoophytes).

Hincks divides the Order into 3 suborders:—

1. *Athecata* (Tubularina, Johnst.), in which true thecæ are absent. Fam.:

1. Clavidæ.	7. Clavatellidæ.
2. Hydractiniidæ.	8. Myriothelidæ.
3. Podocorynidæ.	9. Eudendriidæ.
4. Laridæ.	10. Atractylidæ.
5. Corynidæ.	11. Tubulariidæ.
6. Stauridiidæ.	12. Pennariidæ.

Subord. 2. *Thecaphora* (Sertularina, Johnst.), in which the Hydroida are furnished with thecæ. Fam.:

1. Campanulariidæ.	6. Coppiniidæ.
2. Campanulinidæ.	7. Haleciidæ.
3. Leptoscyphidæ.	8. Sertulariidæ.
4. Lafoëidæ.	9. Plumulariidæ.
5. Trichydridæ.	

Subord. 3. *Gymnochroa*. Polypidom absent; locomotive. Fam. 1. Hydridæ.

BIBL. Johnston, *Brit. Zooph.* 5; Gosse, *Mar. Zool.* 1, 18; Allman, *Ann. N. Hist.* 1863, xi. p. 1; Hincks, *Brit. Zooph.* i.

HYDROMET'RIDÆ.—A family of Hemipterous (Heteropterous) Insects, the species of which are found skimming the surface of pools or rivers. The under parts of the body and legs are covered with fine hairs, which prevent them from becoming wetted. The eggs of *Hydrometra* are elliptical and elegantly sculptured.

BIBL. Westwood, *Introduction, &c.* ii. 467.

HYDROMORI'NA, Ehr.—A family of Infusoria.

The two genera of which it consists, *Polytoma* and *Spondylomorum*, appear to be Monads (species of Algæ) undergoing division. See these genera.

BIBL. Ehrenb. *Ber. d. Berl. Akad.* 1848.

HYDROPH'ILUS, Geoff. See HYDROÜS.

HYDROPH'ORA, Tode.—A genus of Mucorini (Physomycetous Fungi). Moulds growing on the dung of animals, distinguished by the indurated persistent peridiole and the conglobated spores. Two species are described as British.

H. stercorea, Tode. Fleecy; filaments simple, very long, fugacious, white; peridioles spherical, yellow, subsequently black. Common on dung after much rain.

H. murina, Fr. Filaments scattered, short, simple, persistent, white; peridioles yellow, subsequently opaque. On rats' dung. (*Mucor fulvus,* Sowerby, pl. 400. fig. 4.)

BIBL. Berkeley, *Hook. Brit. Fl.* ii. pt. 2. 331; Fries, *Syst. Mycol.* iii. p. 314, *Sum. Veg.* p. 87.

HYDROSE'RA, Wall.—A genus of Diatomaceæ.

Char. Frustules quadrate, areolar, united into a filament, with internal septa; hoop smooth, compressed or triangular in front view, areolar, the constricted angles with a small appendage on one side. Marine.

H. compressa. Valves oblong. East Indies.

H. triquetra. Valves triangular. East Indies.

BIBL. Wallich, *Qu. M. J.* 1858, vi. p. 251.

HYDRO'US, Linn.—A genus of Coleopterous Insects, of the family Hydrophilidæ.

H. piceus is one of the largest aquatic British beetles. We have selected the head to illustrate the structure and arrangement of the trophi, &c. in the Coleoptera (see INSECTS). The perfect insect is about $1\frac{1}{2}''$ in length. The full-grown larva is about $3''$ long; it has no lateral branchiæ, but two filiform branchial appendages at the end of the body.

BIBL. Westwood, *Introduc. &c.*; Duméril, *Consid. gén. s. l. Insectes*; Stephens, *Brit. Beetles.*

HYDRU'RUS, Ag.—A genus of Confervoid Algæ which we have placed for convenience among the PALMELLACEÆ, but which seems to form a link between these and the ULVACEÆ. The frond consists of a branched, feathery, very gelatinous expansion, the branchlets set with minute processes or ramelli (Pl. 3. fig. 8*a*); in the gelatinous substance are imbedded minute cells with homogeneous green contents, most closely set in the ramelli, more scattered in the older part of the frond (Pl. 3. fig. 8*b*). *H. Ducluzelii,* Ag., grows to a length of from 1 to $6''$, and from 2 to $4'''$ in diameter, attached to stones in mountain brooks and rivers; the recent frond is of brownish olive in mass, green when dried. When fresh it has a very offensive smell. Reproduction not described.

BIBL. Harvey, *Brit. Alg.* (1 ed.) p. 180; Hassall, *Br. Freshw. Alg.* p. 302, pl. 77. fig. 3; Kützing, *Tab. Phyc.* pl. 34. fig. 3.

HYGROCRO'CIS, Ag.—A supposed genus of filamentous Confervæ; apparently consisting of the flocculent mycelium of Fungi.

BIBL. Kützing, *Spec. Alg.* 148; Rabenhorst, *Fl. Alg.* ii. 8 (fig.).

HYME'NIUM.—The term applied to the layer of cellular tissue upon which are seated the *basidia* of the higher FUNGI. The name is also applied to the fructifying stratum in such Ascophorous fungi as *Helvella, Morchella, Peziza,* &c.

HYMENODEC'TON, Leighton.—A genus of Graphideæ (Gymnocarpous Lichens), separated from *Opegrapha.* *H.* (*Op.*) *dendritica* and its varieties occur on the bark of beech trees.

BIBL. Leighton, *Ann. Nat. Hist.* 2nd ser. xiii. p. 387; *Eng. Bot.* pl. 1756.

HYMENOMYCE'TES.—The highest order of Fungi, characterized scientifically by the peculiar mode of arrangement of the spores, which are borne in groups of four on the exposed surface of a more or less membranous or sometimes gelatinous layer called the *hymenium.* The fruit, called the receptacle, varies extremely in form. In most of the Tremellini it is an irregular jelly-like or waxy expansion, borne, however, on a roundish support in *Tremella*; in the Clavati it forms a club-shaped, mostly branched, fleshy or leathery stalk-like body (called the *hymenophore*), which is clothed at its ends by the sporiferous membrane or hymenium, forming a smooth layer. In the Auriculati and Hydnei the receptacle is either an expanded, irregular, crust-like, membranous or leathery mass, or has the form of a club, a funnel, or of a hat or cap, the sporiferous membrane clothing either the upper or under surface as a warty, spiny, or comb-like stratum.

In Polyporei and Agaricini the receptacle is a discoid (often laminated), bell-shaped or dish-formed, fleshy body, more or less coloured and tuberculated on the upper side, frequently borne on a columnar stalk inserted on the under side, while the sporiferous layer, or hymenial structure, presents itself as a conspicuous layer on the under

side, consisting of a number of paper-like lamellæ, or vertical tubes, prickles, or pits, closely packed, on the lateral surfaces of which are borne the spores; in many cases, however, the hymenium is perfectly even in the column. The younger stages of development of some Hymenomycetes do not exhibit all these characters, since the receptacle is at first enclosed in a sac-like body arising from the mycelium, so that the external appearance is similar to that of one of the Gasteromycetes (as in very young mushrooms); this sac finally bursts, to allow of the expansion of the receptacle.

The cellular structure of this family is simple, in spite of the varied outward forms; the whole mass, from the filamentous *mycelium* up to the *sporiferous membrane* or *hymenium*, is made up of interwoven branched cellular filaments, of great tenuity. In the Tremellini these filaments are imbedded or dissolved into an amorphous waxy or gelatinous substance; in other cases they form a dry corky structure; but the consistence is generally fleshy. In a few cases among the Agaricini and Polyporei, vesicular or elongated branched cells are met with, of considerable size, containing a milky juice (in the gills of *Ag. deliciosus*, &c.). The *spores* are short terminal branches of roundish or elongated cells, called *basidia*, clothing the free surface of the hymenial structure (see BASIDIOSPORES). They may be seen in thin cross sections cutting the laminæ of the Agarics or the tubes of the Polyporei at right angles, requiring a high power for their observation. Four spores are formed on each basidium, from which they fall off when mature. The Agarics exhibit on the hymenium, among the basidia, peculiar projecting vesicles filled with opaque fluid (*pollinaria*, Corda; *cystidia*, Leveillé; *utricles*, Berkeley), which some have called anthers, but which appear to be *paraphyses*—that is, undeveloped or abortive (bare) basidia. The spores are mostly exceedingly minute, of various forms and colours, and consisting of simple cellules. Tulasne has recently shown that the Tremellini produce *spermatia*, as well as *basidiospores*; in *Tremella*, and other genera, they arise from distinct branches of the hymenial filaments; in *Dacrymyces* they are produced in germination from some of the detached basidiospores lying upon the mycelium (see TREMELLINI).

The structure of these Fungi must be investigated in all stages of development, since very great changes of size and form take place at different epochs, simply from expansion or solution of the cellular textures.

Synopsis of the Families.

1. AGARICINA. Receptacle like a round or flat cap, often borne on a stalk. Hymenium forming vertical plates or folds on the under surface.

2. POLYPOREI. Receptacle like a round or flat cap, disk, cup, or funnel, sometimes stalked, with a porous (formed of tubes) or reticulated hymenium on the under side.

3. HYDNEI. Receptacle like a round or flat cap, cup, or funnel, sometimes stalked, with the hymenium on the under side exhibiting awl-shaped processes or tubercles.

4. AURICULARINI. Receptacle tubular, cup- or funnel-shaped, with the smooth or papillose hymenium on the under surface.

5. CLAVATI. Receptacles club-shaped, simple or branched like a shrub, with the hymenium covering the tips and sides of them.

6. TREMELLINI. Receptacle vague, or cup-shaped, often gelatinous at first, hardening by drying up. Hymenium confounded with the structure of the receptacle, on the upper, under, or both surfaces; basidia terminating the branches of hymenial filaments, accompanied sometimes by branches bearing spermatia. The detached spores often lie imbedded in the gelatinous surface of the hymenium, and sometimes produce spermatia there. The above characters refer to the more typical species, as resupinate forms or an expanded hymenophore occur in each of the divisions.

BIBL. Berkeley, *Lindley's Veg. Kingdom*; *Hooker's Brit. Flora*, vol. ii. pt. 2; *Ann. Nat. Hist.* i. 81, and ix. p. 1; Leveillé, *Ann. d. Sc. N.* 2 sér. viii. p. 321; Fries, *Sum. Veg.* p. 267; Tulasne, *Ann. d. Sc. N.* 3 sér. xix. p. 193.

HYMENOPHYLLA'CEÆ.—A family of Ferns, distinguished by the delicacy of the structure of their leaves and the composition of the sori or fruits. The leaves are of the utmost simplicity of organization, consisting ordinarily of a single layer of cellular tissue, traversed by scalariform tubes constituting the veins. There is no distinction of epidermis and parenchyma, and no stomata.

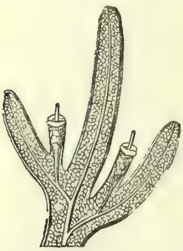
Genera.

Trichomanes. Sporanges sessile around the base of an exserted filiform column, formed by the prolongation of a vein be-

yond the margin of the leaf, surrounded by a cup-shaped indusium continuous with the leaf (fig. 339).

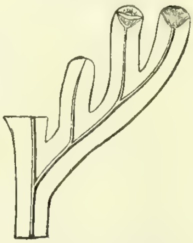
Hymenophyllum. Sporanges sessile up to the summit of a similarly formed column projecting from the margin of the leaf, subelevated, but not exserted beyond the indusium, which is two-valved (fig. 340).

Fig. 339.



Trichomanes humile.

Fig. 340.



Hymenophyllum bivalve.

Fig. 339. Fragment of a leaf, with sori.
Fig. 340. Ditto.

Magnified 10 diameters.

Loxosoma. Sporanges stalked, inserted up to the summit of a subelevated exserted column arising in a similar way within the margin of the leaf, surrounded by an indusium, somewhat within the margins of the fissures between the teeth of the leaf, with a truncated mouth, entire.

Fig. 341.

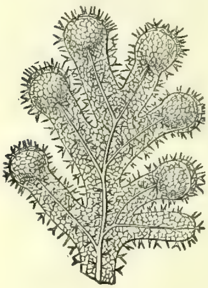


Fig. 342.

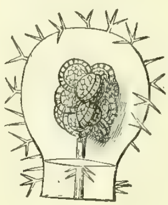
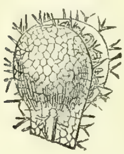


Fig. 343.



Hymenophyllum ciliatum.

Fig. 341. Fragment of a leaf. Magn. 10 diams.
Fig. 342. Sorus with one valve removed. Magn. 40 diams.
Fig. 343. Sorus. Magn. 20 diams.

HYMENOPHYL'LUM, Smith.—Filmy Ferns. The typical genus of Hymenophyllaceous Ferns, remarkable for their delicate structure and often almost moss-like habit. Two dwarf species are natives of Britain, *H. tunbridgense* and *H. Wilsoni.*

HYMENOP'TERA.—An order of INSECTS, containing the Bees, &c.

HYPEROMYX'A, Corda. See CHEIROSPORA.

HYPHEOTHRIX, Kütz.—A genus of OSCILLATORIACEÆ (Confervoid Algæ).

Char. Fil. simple, jointed, more or less distinctly sheathed, tranquil; fasciculate or densely united into a more or less membranous non-radiate stratum.

58 European species. In springs, coating water-plants in pools; on rocks, &c.

BIBL. Rabenhorst, *Fl. Alg.* ii. p. 75.

HYPHOMYCE'TES. — An order of Fungi composed of microscopic plants, growing as moulds over dead or living organic substances. The vegetative structure or mycelium creeps over or among the structures infested as a collection of delicate, simple or branched, continuous or septate filamentous cells (*flocci*), and produces the spores either on lateral pedicels (from which they soon fall off, becoming intermingled with the mycelium), or in heads at the swollen or ramified extremities of usually erect filaments (figs. 344, 345, 346 and 347). These filamentous pedicels in most cases exhibit a contraction just below the point of origin of the spore, giving them the same appearance as the pedicels of basidiospores. The spores are round (Pl. 20,

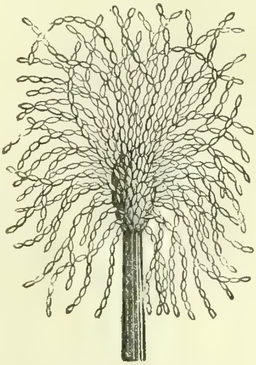
Fig. 344.

Fig. 345.

Fig. 344. Cephalothecium roseum. Magn. 200 diams.
Fig. 345. Botrytis nutans. Magn. 200 diams.

fig. 15), oval (fig. 347 and Pl. 20. figs. 5, 6), spindle-shaped (FUSISPORIUM), spiral (HELICOSPORIUM), and isolated or connected (fig. 346) in beaded lines (PENICILLIUM, ASPERGILLUS), or grouped in a stellate

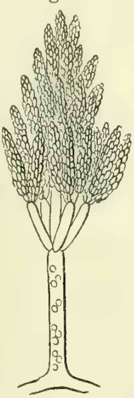
Fig. 346.

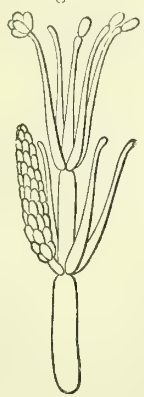


Cephalotrichum Caput-Medusæ.
Magnified 200 diameters.

form. In the Isariacei and Stilbacei the erect pedicels are composed of a number of conjoined filaments; in the other families the pedicels are simple filaments. Some

Fig. 347. Fig. 348.

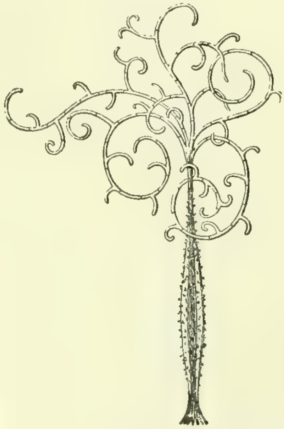




Clonostachys Araucaria.
Fig. 347. Magn. 200 diams.
Fig. 348. A fertile branch. Magn. 400 diams.

authors include among these plants the Mucorini (PHYSOMYCETES), regarding the vesicular envelope of the spores there as a mere *veil*, not a true cell producing the spores in its interior. This family is of especial interest from containing so many moulds and mildews, and various parasitical Fungi to which the diseases of plants, and in some cases of animals, have been attributed. Further particulars respecting these will be found under the Families, also PARASITIC FUNGI.

Fig. 349. Fig. 350.



Ceratocladium microspermum.
Fig. 349. Magnified 200 diams.
Fig. 350. Spores, magnified 400 diams.

Synopsis of the Families.

1. ISARIACEI. Receptacle clavately branched, or assuming Hymenomycetous forms, composed of filaments closely attached in their whole length; spores simple, attached to simple pedicels arising in all parts (fig. 349).

2. STILBACEI. Receptacle wart-like or clavate above, stalked below, composed of filaments closely packed, coherent, terminating singly in free subgelatinous spores.

3. DEMATIEI. Mycelium filamentous, spores compound or simple, arising from the apices of erect, solid, corticate, subopaque filaments (fig. 346).

4. MUCEDINES. Mycelium filamentous, spores solitary, or crowded on articulated or branched tubular and pellucid filaments (figs. 344, 345), soon separating and mingling with the mycelium, or adherent in chained rows.

5. SEPEDONIEI. Mycelium filamentous, spores usually found heaped together resting on the mycelium, and apparently springing out of it directly. The spores are the principal element in this Order, which approaches Coniomycetes.

HYP'NÆA, Lamouroux.—A genus of Rhodymeniaceæ (Florideous Algæ), the only British species of which, *H. purpurascens*, is a common purplish-pink feathered or shrubby sea-weed, the lobes being cylindrical, filiform, and cartilaginous, growing from 2″ to 6″ in height, with the filaments about 1‴ in diam. On stones, rocks, &c. between tide-marks. The fructification consists of *coccidia*, tubercles immersed in the ramuli, each containing a mass of small spores; and *tetraspores*, immersed in the lesser branches, of separate plants.

BIBL. Harvey, *Brit. Mar. Alg.* p. 130, pl. 16 D; *Phyc. Brit.* pl. 116; *Eng. Bot.* pl. 1243.

HYPNOI'DEÆ.—A family of Pleurocarpous Mosses of large extent. Leaves with the cells prosenchymatous, dense or lax, smooth or papillose. Alar cells at the bases of the leaves diverse: 1, square, flattish or ventricosely impressed, pellucid or yellowish, or fuscescent; 2, few, vesicular, placed at the very base, of a delicate yellow or hyaline; 3, obsolete, scarcely any, placed at the very base, fugacious, hyaline, vesicular; 4, many, square, in papillose leaves, but mostly not very conspicuous. Leaves 0–5-nerved. Nerves binate, diverse: 1, divergent from the base, distinct, very callous at the back of the leaf and prominent in the form of a spine from the dorsal surface; 2, flattened down, scarcely callously prominent; 3, in leaves where the alar cells are vesiculiform, the nerves obsolete, indicated by a pair of very short striæ, mostly inconspicuous.

British Genera.

a. *Internal peristome without interposed cilia.*

Neckera. Calyptra dimidiate. Peristome double, single, or absent, the internal or the external or both being occasionally obsolete. External: sixteen equidistant or more or less geminate teeth, lanceolate trabeculate, with a longitudinal line composed of a double layer, arising below the orifice, sometimes split into several irregular arms. Internal: similar to the above, or capillary, placed on a more or less exserted membrane, conjoined by transverse appendages, very often wholly or partly cancellate. No interposed cilioles.

Pilotrichum. Calyptra mitriform. Peristome, &c. as in NECKERA.

b. *Internal peristome with interposed cilia.*

Hookeria. Calyptra mitriform. Peristome double; external teeth lanceolate-subulate, with a more or less broad longitudinal median line, trabeculate; internal on a more or less deep keeled membrane, subulate, scarcely ciliiform; rudimentary cilia interposed hardly conspicuous, or, more rarely, perfect.

Hypnum. Calyptra dimidiate. Peristome double. External teeth sixteen, lanceolate, trabeculate, with a more or less broad longitudinal line, more rarely a fissure, with more or less crest-like prominent trabeculæ within. Internal teeth on a grooved reticulated projecting membrane, lanceolate, articulated, grooved, solid or perforated in the middle, or altogether gaping and separating. Cilia one to four, interposed, very often rudimentary.

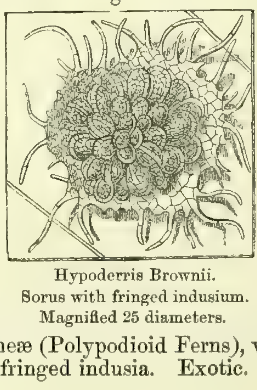
HYP'NUM, Dill.—A large genus of Hypnoideæ (Pleurocarpous Mosses), here including the species referred by modern writers to *Isothecium*, *Climacium*, *Leskea*, &c. Many of them are extremely common in all woods, growing on trunks of trees, banks, &c.; others grow in water or in bogs, &c. The distinctions of the species are taken in great part from the forms &c. of the leaves, which require the use of a microscope for their accurate determination.

BIBL. Wilson, *Bryol. Britann.* p. 335; Hooker, *Brit. Flora*, vol. ii. pt. 1; Müller, *Synops. Muscorum.*

HYPOCREA, Fr.—A genus of Sphæriacei (Ascomycetous Fungi), with a horizontal, sessile, or indistinct fleshy stroma, filiform asci, and simple spores. The species of this genus, like those of *Hypoxylon*, as given by Fries, are partly referred to *Sphæria* by other authors; the distinctions will be best explained by taking all these genera under SPHÆRIA.

HYPODER'RIS, R. Brown.—A genus of

Fig. 351.

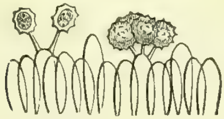


Hypoderris Brownii.
Sorus with fringed indusium.
Magnified 25 diameters.

Peranemeæ (Polypodioid Ferns), with very prettily fringed indusia. Exotic.

HYPOGÆ'I.—A family of Gasteromycetous Fungi, characterized by their resem-

Fig. 352.



Hydnangium candidum.
Basidiospores upon the hymenium.
Magnified 400 diameters.

blance to the Truffles (Ascomycetes) in growing underground, and by their fleshy indehiscent receptacle, which is excavated into sinuous cavities lined with *basidiospores*, which are sometimes smooth and sometimes tuberculated (figs. 352, 353).

Fig. 353.

Hysterangium clathroides.
Section of hymenium with oval basidiospores.
Magnified 400 diameters.

Bibl. Tulasne, L. R. & C., *Fungi Hypogæi*, Paris, 1851; "*Rapport*" on that work, *Ann. d. Sc. N.* 3 sér. xv. 267, and *Ann. N. H.* 2 ser. vol. viii. 19; *Berk. Outl.* p. 292.

HYPOLE'PIS, Bernh.—A genus of Adianteæ (Polypodioid Ferns), remarkable as varying in the condition of the indusium so as to become indistinguishable from Polypodium.

HYPOMY'CES, Tul.—A genus of Sphæriacei (Ascomycetous Fungi), proposed by Tulasne to include the coloured species which are parasitic and spring from a thick floccose mycelium. Their conidia are often extremely curious, and have been referred to *Sepedonium, Asterophora, Dactylium*, &c. The species were formerly included in *Hypocrea*.

Bibl. De Bary, *Bot. Zeit.* 1859, pp. 385, 393; Tul. *Carp.* iii. p. 38.

HYPOPTERYGIA'CEÆ.—A family of Pleurocarpous Mosses with a peculiar arrangement of the leaves, which are placed in two opposite straight rows united on the upper side of the stem, with a third median row of smaller stipuliform leaves on the

Fig. 354. Fig. 355.

Hypopterygium.
Fig. 354. Natural size.
Fig. 355. A leafy branch. Magnified 5 diams.

under side, bearing a resemblance to the intermediate leaves in *Selaginella* (figs. 354, 355). The cells of the leaves are parenchymatous and equal in all parts. The genera are all exotic, viz. *Hypopterygium, Cyathophorum*, and *Helicophyllum*.

HY'POPUS, Dug.—A supposed genus of Arachnida, of the order Acarina, and family Acarea.

Char. Body ellipsoidal, coriaceous; palpi absent; labium oblong, prolonged in the form of a rostrum, and furnished with two long anterior rigid setæ. The species are numerous, and are found as parasites upon both animals and plants, as *Arvicola* (the field-mouse), *Bombus* (the humble-bee), *Musca* (fly), some Myriopoda; also upon ferns, &c. Dujardin has rendered it probable that they are young forms of *Gamasus*. They have no mouth nor digestive organs.

Pl. 2. fig. 15 represents a *Hypopus muscarum*, which we found upon a house-fly (*Musca domestica*).

Bibl. Dugès, *Ann. d. Sc. Nat.* 2 sér. i. p. 20, ii. p. 37; Gervais, *Walckenaer's Arachn.* iii. p. 265; Dujardin, *Ann. d. Sc. Nat.* 3 ser. xii. pp. 243 & 259.

HYPOTHE'CIUM.—The term applied to the layer of cellular tissue, on which are attached the thecæ or spore-sacs of the fruits of the Lichens.

HYPOX'YLON, Fries.—A genus of Sphæriacei (Ascomycetous Fungi), distin-

guished by a sessile stroma, separate and distinct from the matrix (see SPHÆRIA). The *Hypoxyla* of Bulliard with an erect stroma belong to XYLARIA.

HYSTE'RIUM, Tode.—A genus of Phacidiacei (Ascomycetous Fungi), distinguished by the elliptical or elongated perithecia (figs. 356, 357), bursting by a simple longitudinal slit. The species are numerous, growing upon (usually dead) bark, stems and leaves of various plants. *H. rugosum* has been placed by some authors among Lichens (as *Opegrapha macularis, epiphega*, Eng. Bot.). It is common on smooth *living* branches of oak and beech. *H. pulicare*, *H. Rubi*, *H. Pini*, and *H. culmigenum*, the grass *Hysterium* and *H. foliicolium*, growing on leaves of hawthorn, ivy, or oak, are common. The species with septate spores (fig. 359) form the genus *Hysterographium*, Corda.

Fig. 356.

Fig. 357.

Hysterium degenerans.

Fig. 356. Natural size.
Fig. 357. Perithecium. Magnified 10 diameters.

Fig. 358.

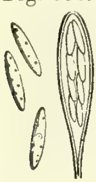


Fig. 359.

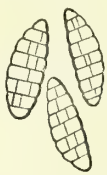


Fig. 358. Hysterium foliicolium β Hederæ. An ascus containing eight spores, magnified 100 diameters; with loose spores, magnified 200 diameters.

Fig. 359. Hysterium elongatum. Spores. Magnified 400 diameters.

BIBL. Berk. *Hook. Br. Flora*, vol. ii. pt. 2. p. 293; *Ann. N. H.* 2 ser. vii. p. 185; Fries, *Sum. Veget.* p. 368; Greville, *Sc. Crypt. Fl.* pls. 24, 26, 72, 87, 88, 129 & 167.

I.

ICHTHYDI'NA, Ehr.—A family of Rotatoria.

Char. No carapace; rotatory organ single, continuous, not lobed nor divided at the margin.

The rotatory organ is in the form of a circle in *Ptygura* and *Glenophora*; in *Ichthydium* and *Chætonotus* it is long, band-like, and placed upon the ventral surface.

The family is thus divided:—

Eyes absent,	
No hairs present,	
Tail-like foot simple and truncate	*Ptygura.*
" forked	*Ichthydium.*
Having bristly hairs,	
Tail simple, truncate	*Dasydytes.*
Tail forked	*Chætonotus.*
Eyes single, frontal	*Sacculus.*
Eyes two, frontal	*Glenophora.*

Dujardin places *Ichthydium* and *Chætonotus* among the Infusoria; and *Ptygura* among his Melicertina.

BIBL. Ehrenberg, *Infus.* p. 386; Dujardin, *Infus.*; Schultze, *Müll. Archiv*, 1853, p. 241.

ICHTHYD'IUM, Ehr.—A doubtful genus of Rotatoria, of the family Ichthydina.

Char. Eyes absent; body without dorsal hairs; pediform tail forked.

Locomotion is effected by cilia placed upon the ventral surface.

Dujardin places this genus among his symmetrical Infusoria.

I. podura (Pl. 24. fig. 23). Body linear-oblong, often slightly constricted near the anterior turgid and sometimes trilobate end; foot short; aquatic; length 1-140''.

BIBL. Ehrenberg, *Infus.* p. 388.

IDMO'NEA, Lamx.—A genus of Infundibulate Cyclostomatous Polyzoa, of the family Tubuliporidæ.

Distinguished by the erect dichotomously divided polypidom; and the tubular cells, on one side only, in transverse rows, divided into two sets by a median longitudinal line.

I. atlantica. Branches roundish, tapering to a point; cells four in each row, the innermost tubes considerably protruded. Height 4-10''.

BIBL. Johnston, *Brit. Zooph.* 278; Busk, *Brit. Mus. Cat. Marine Polyz.*, *Foss. Pol. Crag*, *Pal. Soc.*

I'DUNA, Cl. & Lachm.—A genus of Infusoria, fam. Ervilina.

Char. Those of Ervilina with a carapace, but with perfectly distinct valves.

I. sulcata. Right valve with four raised longitudinal ribs; left valve plane and smooth. Northern sea. Length 1-180''.

BIBL. Clap. and Lachm. *Infus.* p. 283.

ILLICIUM. See WINTEREÆ.

ILLOSPORIUM, Mart. — A genus of Stilbacei (Hyphomycetous Fungi), mostly rose-red gelatinous bodies growing upon Lichens, described as consisting of irregular spores, at first involved in a globule of mucus, and afterwards glued together in simple mealy patches (these plants seem

very obscure). Four species are described as British:

I. roseum, Fr. (Grev. *Sc. Crypt. Fl.* pl. 51).

I. carneum, Fr. (Corda, *Icon. Fung.* iii. fig. 1).

I. corallinum, Rob. (Desmaz. *Exsicc.* no. 1551).

I. coccineum, Fr. (Cord. *l. c.* fig. 3).

Bibl. *Op. cit.* and Berk. *Brit. Flora*, ii. pt. 2, p. 328; *Ann. Nat. Hist.* 2 ser. v. 466; Fries, *Summa Veget.* 482; *Syst. Mycol.* iii. 259.

ILLUMINATION.—So much has been said in the Introduction and in the articles Angular aperture, Diatomaceæ, Polarization, and Test-Objects, upon the subject of illumination in general, and of the effects of various kinds of illumination in rendering evident the different structural peculiarities of objects, that we shall merely add here two illustrations of the importance of attention to the physiological effects of a variation in the relative amount of light transmitted by or reflected from the parts of an object, or of contrast as it is popularly called.

If two candles, the flames of which are of equal size and height, be placed parallel to and 2 or 3 feet from a painted wall or other uncoloured surface, and a piece of string be suspended at an inch or two from the wall, and opposite the interspace between the two candles, on lighting one of the latter, the surface of the wall will be illuminated at all points except those corresponding to the shadow of the string. But on lighting the other candle, two shadows will become visible, the second lying in the direction of a line drawn from the second candle through the string to the wall. Thus by throwing an increased amount of light upon all parts of the wall except the line corresponding to the shadow of the second candle, this line will appear dark or even black; whereas it might have been expected that this portion would have appeared to the eye as light as it was before, which is not the case. Again, if we take a section of the shell of a hen's egg or any similar object, and illuminate it by reflected light, all the more opaque parts will appear white and luminous; but on transmitting light from the mirror through the object, the reflected light being unchanged, the whole appearance will be altered, the parts which were before white will now become black, and *vice versâ*.

These experiments show that it cannot be concluded from the dark appearance of parts of an object that light is not reflected from or transmitted through them; for parts may be made to appear dark or black by simply throwing more light upon the surrounding parts, so that darkness may indicate either absolute or comparative absence of light. This important point must always be borne in mind in determining the cause of the appearances of objects under different kinds of illumination.

A résumé of the subject will be found by Higgins, *On Micr. Illum. Qu. Journ. Mic. Sci.* vol. x. n. s. p. 150.

A new and valuable method of illumination is described by Wenham, *M. M. J.* 1872, p. 23.

ILYOBA'TES, G. O. Sars.—A genus of Ostracoda (Entomostraca), of the family Cytheridæ. Lower antennæ four-, upper five-jointed, with the last three joints short and stout; first two pairs of feet three-jointed; eyes wanting.

1 species.

Recent in Norway, Britain, Bay of Biscay. *Fossil.* Tertiary, England.

Bibl. Brady, *Brit. Ost. Tr. Linn. Soc.* xxvi. pt. 2, p. 431.

ILYOCRYP'TUS, G. O. Sars.—A genus of Macrotrichidæ (Entomostraca).

1 species.

Britain, Russia, Germany, Sweden.

Bibl. Norman and Brady, *Mon. Brit. Entom. Nat. Hist. Trans. North.* vol. i. p. 17.

IMBRICARIEI.—A subtribe of the Phyllodei (Lichenacei).

Bibl. Nyl. *Syn.* t. 8. f. 48; Leighton, *Lic. Flo.* p. 121 (1871).

IMPERFORA'TA.—A suborder of the order Reticularia, Foraminifera, characterized by the presence of one aperture only, usually simple, in the shell, which is either membranous (family Gromida), porcellaneous (fam. Miliolida), or arenaceous (fam. Lituolida), and has no pseudopodial pores or tubules.

Imperforata (see Foraminifera).

Bibl. Carpenter, *Introd. For.* 62.

INAC'TIS, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ).

Char. Filaments sheathed, indistinctly jointed, parallel, sometimes dichotomous, densely aggregated, and forming a pulvinate hemispherical frond, springing from a substratum of *Protococcus*-like cells.

In pools, on other Algæ; on rocks, &c.

3 species with several varieties.

BIBL. Kützing, *Phyc.* 77; Rabenhorst, *Fl. Alg.* ii. p. 159 (fig.).

INDIAN RUBBER, or CAOUTCHOUC.—This substance occurs naturally in globules suspended in the milky juices of many plants, especially of the Orders Euphorbiaceæ, Urticaceæ, and Apocynaceæ. The form of the globules is varied. In Pl. 39. fig. 23 is represented part of a milk-vessel of *Euphorbia antiquorum* with two caoutchouc globules. When such milky juices are evaporated, the globules become blended into a uniform elastic mass, the India-rubber.

Solution of caoutchouc is sometimes used as a cement for closing glass cells; but its chief importance in this respect depends on its forming a constituent of *marine* glue (see CEMENTS).

INDICATOR, QUEKETT'S. — Used with Slack's diaphragm eyepiece. It is a small steel hand placed just over the diaphragm, so as to point to nearly the centre of the field. It can be moved at pleasure.

BIBL. Carpenter, *The Microscope.*

INDIGO.—This well-known vegetable substance is chiefly obtained from plants of the genera *Indigofera* and *Isatis*, and *Polygonum tinctorium*, but may be found in many others.

It has also been found in human urine, of which it is probably a normal constituent. Its best marked character is that of subliming in flattened prisms and plates (Pl. 6. fig. 14).

Indigo is sometimes used as a colouring-matter for injections, and is also very useful for colouring the internal cavities of Infusoria which swallow the granules, for rendering visible ciliary motion (see INTRODUCTION, p. xxxii), &c. The simplest mode of employing it is to rub it from a water-colour cake of indigo very gently with a little water. The Infusoria require to be left in the coloured mixture some time; and it is well to remove them into clean water for examination.

Indigo-carmine forms the basis of some excellent staining solutions.

BIBL. See CHEMISTRY.

INFLAMMATION.—The phenomena of inflammation are best studied in one of the lower animals, as in the web of the frog's foot, the mesentery of the frog, the tail of the tadpole, or of the larva of the water-newt (*Triton*), the process being excited by the application of a hot needle, a solution of common salt, ammonia, dilute spirit, or volatile oil.

The principal phenomena are as follows:—

1. *Changes in the blood-vessels and circulation.*

2. *Exudation of liquor sanguinis and migration of white blood-corpuscles; and*

3. *Alterations in the nutrition of the inflamed tissue.*

1. The first effect of irritation of the mesentery (mere exposure to the air being sufficient for the purpose) is to cause dilatation of the arteries, and subsequently that of the veins. The dilatation of the arteries commences at once, and is not preceded by contraction. It gradually increases for about twelve hours, and is associated at the commencement of the process with an acceleration in the flow of blood; this, however, is soon followed by a considerable retardation. These alterations in the rapidity of the blood-flow, however, cannot be owing to the increase in the calibre of the vessels, which remain throughout dilated.

The retardation of the circulation usually commences somewhat suddenly, and is first observable in the veins. The rapidity of the current varies, however, in different vessels; in some (both arteries and veins) it may be more rapid, in others very slow, and either oscillating to and fro, or even completely stagnant. These differences may occur in contiguous vessels. The capillaries and small arteries often present at the same time numerous irregular bulgings and contractions.

As the circulation becomes slower, the white blood-corpuscles (leucocytes) accumulate in the veins. Their natural tendency to adhere to the sides of the vessels is increased, so that they may nearly fill the tube. At the same time they exhibit active movements, by means of which they penetrate the walls of the vessels and pass into the surrounding tissues. The absolute number of white blood-corpuscles may also be increased owing to the irritation of the lymphatic structures in the vicinity of the inflamed tissue.

The red corpuscles also accumulate in the capillaries. They adhere to one another and to the sides of the vessels, and become so closely packed that their outlines can scarcely be distinguished. Increased adhesiveness of the red corpuscles has long been regarded as characteristic of inflammatory blood, by virtue of which they exhibit a greater tendency to cohere in rolls than in health.

The diminution in the rapidity of the circulation, and the accumulation of the blood-corpuscles in the vessels, is followed by the complete stagnation of the current, constituting the condition long known as *inflammatory stasis*.

2. Another constituent of the inflammatory process consists in the exudation of liquor sanguinis and migration of white blood-corpuscles.

The migration of white blood-corpuscles (leucocytes) through the walls of the blood-vessels was first described by Dr. W. Addison in 1842. This observer stated as the result of his researches, that in inflammation these corpuscles adhered to the walls of the vessels and passed through them into the surrounding tissues. In 1846 Dr. Augustus Waller described more fully the same phenomenon; and he actually observed the emigration of the corpuscles. Both these observers concluded that the escaped blood-corpuscles became pus-corpuscles. Cohnheim in 1867 brought the subject forward; and to him we owe most of our present knowledge respecting it.

The migration may be observed in the mesentery of a frog which has previously been paralyzed by the subcutaneous injection of Curare.

The white blood-corpuscles (leucocytes), which have accumulated in large numbers, especially in the veins, remain almost stationary against the walls of the vessel, the blood-current passing by them, although with much diminished velocity. Those immediately adjacent to the wall gradually sink into it, and pass through it into the surrounding tissue. In doing so they may be observed in the various stages of their passage. At first small button-shaped elevations are seen springing from the outer wall of the vessel. These gradually increase until they assume the form of pear-shaped bodies, which still adhere by their small ends to the vascular wall. Ultimately the small pedicle of protoplasm by which they are attached gives way and the passage is complete, the corpuscle remaining free outside the vessel.

There can be no doubt that the passage of the corpuscles is effected by virtue of their own amœboid activity, by means of which they penetrate the walls of the vessels. The capillaries are now known to consist of protoplasm; and hence the penetration of their contractile walls by the amœboid corpuscles, and the subsequent closure of the openings when the transit is completed, can be readily understood. The corpuscles having escaped from the vessels into the surrounding tissues, continue to exhibit active movements. They may multiply by division, and thus rapidly increase in number: this will be again referred to when speaking of the origin of pus.

Not only is there a migration of white blood-corpuscles in inflammation, but the red corpuscles also pass through the walls of the blood-vessels, though in less considerable numbers; and their transit is mainly through the walls of the capillaries. This passage of the red corpuscles takes place in simple mechanical congestion; and it may be observed in the web of a frog in which congestion has been artificially induced by ligature of the femoral vein.

Associated with the passage of the blood-corpuscles through the walls of the vessels, is an exudation of the liquor sanguinis. The exuded liquor sanguinis (which constitutes the well-known inflammatory effusion) differs from the liquid which transudes as the result of simple mechanical congestion, inasmuch as it usually contains a larger proportion of albumen and fibrin, a proportion which increases with the intensity of the inflammation. It also contains an excess of phosphates and carbonates.

The most characteristic feature of inflammatory effusion is the large number of cell-structures which it contains. These are the direct product of the inflamed tissue, and are in no case generated spontaneously in the effused liquid. Most of them are migrated blood-corpuscles; and others are derived from the proliferating elements of the tissue. The quantity and nature of the effusion will thus vary with the particular tissue inflamed, and with the severity of the inflammatory process. In non-vascular tissues, as cartilage and the cornea, exudation can only occur to a small extent from the neighbouring vessels, and hence the effusion is small in quantity. In dense organs (as the liver and kidney, owing to the compactness of the structure) a large amount of effusion is impossible; and what there is, is so intermingled with the structural elements of the organ, that it does not appear as an independent material. In the kidney it escapes into the urinary tubes and so appears in the urine. The effusion is most abundant, and constitutes an important *visible* constituent of the inflammatory process, in inflammation of those organs which possess

a lax structure and in which the vessels are but little supported (as the lungs, and in tissues which present a free surface) as mucous and serous membranes.

3. The remaining constituent of the inflammatory process consists in an alteration in the nutrition of the inflamed tissue. The nutritive changes, although they may differ according to the structure of the part, are all characterized by an increase in the nutritive activity of the cellular elements. The nature of these nutritive changes has for the most part been ascertained by the investigation of tissues in the lower animals, in which inflammation has been artificially induced. In man the study of the primary tissues is difficult, owing to the fact that the process can rarely be observed in its earlier stages. The alteration in nutrition, as already stated, is characterized by an exaltation of the nutritive functions of the cellular elements of the tissues involved in the inflammatory process. This is evidenced by an increase in the activity of those elements which normally exhibit active movements, as the amœboid cells of connective tissue and of the cornea. Cells, which, under normal circumstances, undergo no alterations in form, and exhibit no active movements, become active (sending out processes and undergoing various alterations in shape). This increase in the activity, and variation in the form, of the cells is in most cases followed by enlargement and division of their nuclei and protoplasm, and thus by the formation of new cells.

This increased activity of the cellular elements varies considerably in different tissues, and even in the elements of the same tissue. Some cells exhibit active movements, and form new cells, much more readily than others. Those tissues, for example, which naturally maintain themselves by the multiplication of their elements, as the epithelial tissues, become active very readily in inflammation, very slight degrees of irritation being sufficient to cause in them rapid cell-proliferation. This is seen in inflammation of mucous membranes, and of the epidermis. In tissues, on the other hand, whose elements normally exhibit no tendency to multiplication, as common connective tissue, cartilage, and bone, active changes are much less readily induced; the cells are much more stable, and multiply with far less facility. Lastly, in the higher tissues the stability of the elements reaches its maximum, and in nerve-cells no increase of activity can be induced. Different cells in the same tissue exhibit also different degrees of stability. In common connective tissue and the cornea, for example, the amœboid cells are the least stable, and are the first to multiply. Possibly the age of the cells may influence their tendency to become active, the newer being less stable than the older elements. In all cases, however, the rapidity and extent of the proliferation are in direct proportion to the intensity of the inflammation. The earliest nutritive change is thus one of cell-proliferation; the subsequent ones are characterized either by impairment of nutrition and the degeneration and death of the newly formed elements, or by the development of these into a permanent tissue. The more intense the inflammation the greater is the rapidity of the cell-proliferation, the more abortive are the young cells, and the less is their tendency to form a permanent tissue. In connective tissues these changes in the cells are necessarily accompanied by changes in the intercellular substance. The latter are for the most part characterized by softening. In common connective tissue the fibres in the first place become succulent and less distinct, and ultimately they are completely destroyed; in cartilage the matrix softens and liquefies; in bone the lime-salts are removed, the lamellæ disappear, and the osseous structure becomes converted into medullary tissue. Hence the destructive effects of the inflammatory process.

The inflammatory exudation, consisting of emigrant cells, which often undergo fissiparous multiplication, of the proper cells of the inflamed tissue, which undergo increase of size and numbers, and of the fibrinated liquor sanguinis, may undergo *resolution*, *organization*, *suppuration*, and *organization after suppuration*:—

Resolution, by distribution of the emigrant cells over a wider area, and their return into the lymphatics, and by a process of fatty degeneration of the cellular elements.

Organization, by the timely development of blood-vessels, and the conversion of the exudation into fibrillar connective tissue. The cells which are not devoted to the formation of blood-vessels, grow spindle-shaped, and are so closely packed that they give rise to a new variety of tissue. It forms cylindrical or slightly flattened bundles which interlace.

Suppuration. See Pus.

Organization after suppuration (see ORGANIZATION and VASCULARIZATION). It is convenient now to mention that exudation-corpuscles (Pl. 30. fig. 7) are the products of the fatty degeneration of inflammatory exudations.

BIBL. Works on Medicine; Lebert, *Phys. Pathol.*; Wedl, *Path. Hist.*; Förster, *Path. Anat.*; Paget, *Lect. on Inflam.*; Gluge, *Atlas d. path. Anat.*; Lister, *Qu. Mic. Jn.* 1859, vii. p. 139; Cohnheim, *Ueb. Entz. u. Eiter.*, *Virchow's Archiv*, xl. p. 1; Stricker, *Qu. Mic. Jn.* 1870, x. 242; Rindfleisch, *Man. Path. Hist.* vol. i. *New Syd. Soc.*; Sanderson, *Holmes's Syst. Surg.*; Lister, *Infl.*, *Phil. Trans.* 1859; Green, *Infl.*, *Path. and Mor. Anat.*

INFUNDIBULA'TA.—An order of Polyzoa. (See POLYZOA.)

INFUSO'RIA.—A class of Animals.

Char. Microscopic animals not furnished with either vessels or nerves, but exhibiting internal spherical cavities; motion effected by means of cilia, or variable processes formed of the substance of the body, true legs being absent.

(Body composed of proteine compounds; soluble in solution of potash.)

Every one who has examined with a microscope a drop of water containing animal or vegetable matter which has been set aside for a time, or a drop from any pool or ditch, must have observed numerous minute beings in active motion, resembling some of those figured in Pls. 23, 24, & 25; these are Infusoria, or the animalcules of infusions.

Perhaps no question has been more discussed than that of the structure of the Infusoria. Ehrenberg regarded them as being highly organized, and furnished with distinct organs like the higher animals; whilst more recent authors consider them as representing simply a nucleated cell. Unfortunately the facts are not accordant with either of these views, and the question must be considered as still *sub judice*.

It is impossible, as yet, to determine the exact classificatory position of the Infusoria, or to limit them as a class satisfactorily. Ehrenberg and the earlier writers, to whom science is so much indebted for a vast amount of elaborate investigation, included amongst the Infusoria many microscopic Algæ, numerous Rhizopoda, the Rotifera, and many larvæ and other young forms of more highly organized creatures. These have been eliminated with the progress of microscopical research; but there still remain, even in the admirable classification of Claparède and Lachmann, some groups of minute beings which the tendency of the age would relegate to the Rhizopoda. The Infusoria are associated with the Spongida, Rhizopoda, and Gregarinida in the subkingdom Protozoa, and are remotely allied to the lower Annuloida through the Rotifera. But until the nature of the complicated life-cycle of most of the Infusoria has been carefully studied, they must remain as a group, which is unsatisfactorily distinguished from the Algæ, Rhizopoda, and Spongida.

A typical Infusorian has its more or less flexible body covered with vibratile cilia, which appear to spring from a cuticle. They are collected in rows around an opening or mouth, which leads to a gullet terminating in the soft sarcode of the centre of the body. This central portion of the granular and otherwise structureless sarcode is surrounded by a denser or cortical layer, which underlies and develops the cuticle. In the cortical layer are the vacuoles and the nucleus and nucleolus, whilst in the inner mass are the spaces which are produced by the ingestion of food and water, and which are improperly termed "stomachs." Hence the former name, "the *Polygastrica*." There is a rotatory movement of the soft sarcode surrounding these digestive spaces, which causes them to change their positions before they disappear. The animalcule moves some of its cilia voluntarily, and others appear to be in constant movement: and they are the principal locomotive and ingestive organs. It is subject to several methods of multiplication, such as spontaneous division, gemmation, and sexual conjugation. The diversity of shape and structure is very great amongst the Infusoria; and it is therefore necessary to consider the details of the different parts composing them separately and in order.

Integument.—The bodies of Infusoria consist of sarcode, of which the outer layer possesses usually considerably more consistence than the internal portion. Cohn demonstrated the presence of this pellicular layer in *Paramecium* by the addition of alcohol, and noticed that the softer tissues remained united to it by a process in one place only, where the short gullet, which is also lined by a continuation of the external tissue, dips down and merges into them. This hard transparent pellicle or cuticle is

elastic, but its contractility is doubted; and it often becomes visible when the Infusoria are kept in a small quantity of water upon a slide, the globules of sarcode which escape from rupture of the body carrying it before them. It is frequently beautifully marked with minute depressions (Pl. 25. fig. 1), regularly arranged, and from each of which a cilium arises. This cuticle must be regarded as a secretion from the outer or cortical layer of the sarcode; and it is by no means improbable that Leydig's assertion that it arises from a layer of extremely delicate and small cells will turn out to be correct.

Many Infusoria have a carapace or lorica, which is in some soft and in others very hard; the relation of the hard carapace to the pellicular layer is not, however, very distinctly known. The carapace is often not adherent to the body of the Infusoria, but forms a kind of sheath for the protection of the soft tissues; or it may form one or two valves which are more or less completely soldered together. These tests are thicker and less elastic than the cuticle; and the peduncles which support many species of Infusoria, and which in some instances are hollow and contain a contractile sarcode by which they are secreted, belong to the same kind of structures. Beneath the pellicular layer, the substance of the body frequently appears thicker, although no distinct layer can be separated; and it is doubtful whether the markings are situated in the outer coat, or whether the latter derives them from being moulded upon the inner coat, to which they may properly belong.

This cortical layer (parenchyma of Claparède and Lachmann), as it is called, is firmer than the central and more diffluent sarcode, with which it is continuous internally. It is almost homogeneous; but an indefinite and irregular reticulation and fibrillation may be observed in many species, and especially in the Vorticellæ, close to the insertion of the peduncle, with whose contractile fibre it is continuous. The fibrils and the so-called muscles of the peduncle are composed of sarcode, which has no definite structure, and which is here and there faintly granular; but they possess the power of contracting more or less. Besides these, there are the minute granule-looking cells immediately under the pellicle (which have already been noticed), the contractile vesicles or spaces with their ramifications, the nucleus and nucleolus, and sometimes chlorophyl-granules. When present, the brightly coloured pigment-spots, the so-called eyes, appear to be produced in this layer; and the whole of the cilia are continuations of it. Strethill Wright has observed amœboid movements in this layer; but they must not be confounded with the rotation of the central sarcode, which it bounds externally. The portion of the body which is surrounded by and more or less continuous with the cortical layer, and which is subject to rotation, is softer and often contains granules and corpuscles resembling fat-cells. The mouth and gullet open into this central sarcode; and the anus, the existence of which is doubtful in some species, leads from it. Numerous digestive vacuoles are observed in this watery sarcode, which often presents the appearance of being faintly divided and subdivided by films and fibres of less diffluent protoplasm.

The existence of the outermost coat or pellicle is demonstrated by the phenomenon of *ecdysis*, which occurs in certain species. But these membranes or pseudo-membranes do not appear to exist in all cases; for in some Infusoria the body adheres readily to the glass of the slide on which it is viewed under the microscope, and is torn up into fragments in the endeavour to free itself.

The cortical layer of some species produces trichocysts or thread-cells (Allman). These fusiform, colourless, and transparent bodies, 1-2500″ in length, are arranged on the outside of the body and are perpendicular to it. Irritation of the surface causes them to be transformed into long filaments; and they are more or less like the thread-cells of the Polypes; but they are developed within the cortical layer, and not as cells on its surface.

Locomotive organs.—No distinct muscular structure can be detected in the Infusoria, but a contractile power is possessed by the general substance of the body. In *Vorticella* (Pl. 25. figs. 21 *a* & 27) and some others, the contractile substance is prolonged through the hollow pedicle, thus forming a spurious muscular band.

The other directly or indirectly locomotive organs are thus distinguished. 1, cilia: these are the most common, and form the fine, short, very transparent, hair-like filaments projecting from the surface. In some they entirely cover the surface, whilst in others they are arranged in one or more rows round the mouth or upon the ventral surface, &c., as described under the genera.

During life they are seen actively vibrating; and in some their motion appears constant; whilst in others it is interrupted at intervals, apparently under the influence of a will. They are most distinctly seen when the Infusoria are dried (see CILIA). 2, flagelliform filaments (Pl. 24. fig. 59), which are long anterior cilia, the ends alone being vibratory and movable in all directions; there are usually one or two only. 3, retracting cilia or filaments (Pl. 23. figs. 12, 18 *a*; Pl. 24. fig. 17): these are single, long, flexuous, and directed backwards; they frequently become adherent to the slide, and produce a sudden, backward motion of the animal. 4, setæ or bristles (Pl. 24. fig. 53): these are rigid, filiform, straight, and movable, but not vibratile, and are sometimes provided with a bulb at the base; they can be slowly raised or depressed, and serve for support, walking, or climbing. 5, styles (Pl. 25. fig. 17) are thick, straight, very movable setæ, without bulbs, sometimes having setiform branches; they neither rotate nor vibrate. 6, uncini or hooks (Pl. 41. fig. 13) are short, thick, curved, sometimes cleft setæ, serving for prehension, climbing, or creeping, and are bulbous and usually very thick at the base.

The long straight cirri of *Halteria* (Pl. 41. fig. 12), by which the saltation of these Infusoria is produced, probably come under the fifth series; but the foot of such genera as *Dysteria* (*Ervilia*, Duj.) (Pl. 23. fig. 52), which is used for locomotion, and also as a peduncle, is the homologue of the contractile sarcode in the hollow pellicular peduncle of *Vorticella*.

The flagellum of a marine *Ceratium* which was observed by Claparède, suddenly disappeared during a rapid contraction. It retracted into a spherical cavity, which was placed close to its point of insertion. Probably this power of retracting has something to do with the alimentation of the cilio-flagellate Infusoria.

Nervous system.—None has been discovered. In the naked Infusoria, the sense of touch is diffused throughout the substance of the body. In others, it is particularly developed in the snout-like appendages of the body, and in the longer cilia, setæ, &c. The Infusoria are probably all sensible to light; and many of them exhibit, near the anterior part of the body, one or more coloured (mostly red) specks, which have been regarded as eyes; but they contain no distinguishable cornea, nor lens, nor are they connected with any appreciable substance comparable to nervous matter.

The pigment-spot is composed of a collection of minute and highly refracting granules, and in some species it is associated with Lieberkühn's "watchglass-like organ." This is a very minute, transparent, colourless and hard part of the cortical layer, which has its convex side towards the pigment-spot and the concave towards the head; but it is not dependent on the presence of the pigment, for some species possess it which have no pigment-spot, and *vice versâ*. Similar specks occur in the same situation in the spores of many Algæ; moreover the eye-specks are most distinct in those genera which are doubtful Infusoria. Hence it may be denied that they represent eyes; yet they bear considerable resemblance to the eyes of the Rotatoria and some Annelida; so that their true nature must be considered problematical.

Digestive system.—On attentively examining Infusoria under a high power (1-4 to 1-8), a number of roundish spots are generally visible in the substance of the body; they are sometimes filled with a whitish granular matter; at others they contain Desmidiaceæ, Diatomaceæ, or other Algæ, or bodies existing in the surrounding water. These have been called gastric vesicles, cells, spaces, vacuoles, or sacculi. They are only visible from their contents, and no membrane can be distinguished in them. If a little indigo or carmine be added to the water containing the Infusoria, these cavities will soon become filled and will be rendered very distinct; in the Plates they are represented as filled with these pigments.

On attentively watching them, they will appear to move around the body of the animalcule, sometimes two of them appearing to become fused into each other, or the contents of one to pass into another.

Finally, the pigment will be seen to escape at some part of the surface of the body, when the spots will vanish.

Different views have been entertained in regard to the nature of these spots or cavities. By the older observers, they were regarded as internal cavities, into which water was admitted with any particles accidentally suspended in it, forming a means of bringing a greater extent of surface of the substance of the animalcule into contact with the water, and thus aiding in respiration.

Ehrenberg regards them as dilated cæca, or portions of a true alimentary canal (Pl. 24 *a*); whilst Dujardin considered them vacuoles arising in the same manner as those found in sarcode from whatever source derived; others have viewed them as cells floating loosely within the body. Most observers deny that they are portions of an alimentary canal, and that such canal exists, but seem inclined to adopt the opinion that they are cavities irregularly formed in the substance of the body by the introduction of the foreign matters, which are urged through it by its contractions, or moved onwards by its circulation. They are certainly not cells; otherwise they could not so readily admit particles of colouring matter, &c., nor could their contents become fused together, as is sometimes seen to occur. They do not appear to be simply vacuoles filled in the ordinary manner by the surrounding liquid, because the pigment is accumulated in them in greater proportion than it exists in the liquid. In many Infusoria, the particles are admitted at a definite orifice, representing a mouth; this is round or oval, sometimes situated at the anterior end of the body, sometimes more posteriorly or even at the commencement of the posterior third of the body; and it is generally indicated by a circle, fringe, or some other definite arrangement of the cilia, which bring the particles towards it. Sometimes a distinct œsophagus lined with cilia leads to the internal substance, or to the sacculi. The course which the particles (apparently in gastric cavities) take is usually irregular, but sometimes tolerably definite, down one side of the body and up the opposite. The manner in which the undigested particles are evacuated is also an unsettled question; for whilst Ehrenberg and, more recently, Lachmann admit either the existence of a distinct excretory orifice, or evacuation by the mouth, other authors assert that these particles may be evacuated at any part of the surface of the body. According to the recent observations of Lachmann, the cavity of the body of the Infusoria represents a large digestive cavity, as in *Hydra* &c., the contents constituting chyme, and there is a distinct mouth and anus.

The question then must remain whether there is a distinct alimentary canal, the walls of which are invisible on account of their extreme delicacy, or whether the particles drawn in by the cilia are urged at random through the substance of the body. The fact that distinct walls cannot be detected, is of no great weight in opposition to the former view, because the radiate contractile vesicles of *Paramecium* exhibit no walls, and are quite invisible when contracted; and the excretory vessels of *Distoma,* although having distinct walls, are seen to contract and then to vanish completely (Van Beneden).

It may easily be ascertained by experiment that some Infusoria will imbibe bisulphuret of mercury as readily as indigo or other matters, and thus would appear to be entirely deprived of any selecting power governed by a sense of taste; but some kinds would seem to have a sense of taste: *Coleps,* for instance, greedily devours the substance of crushed Entomostraca and their ova, becoming greatly deformed in the operation.

The vacuoles or digestive cavities are frequently very distinct when the animalcules are dead, and especially when dried. If the animalcules be fed with colouring-matter, on drying them, the vacuoles thus rendered distinct will be found to contain the pigment, which is in favour of Dujardin's view.

Surrounding the mouth in some Infusoria, as *Nassula, Prorodon, Chilodon,* and *Chlamidodon,* is a horny cylinder of rod-like bodies called teeth (Pl. 23. figs. 27 *a, b*, 29; Pl. 24. figs. 40, 45, 72): they do not appear to exert any triturating power; and their true signification is unknown. In some Infusoria an œsophagus is also present, as in *Vorticella, Carchesium, Epistylis, Oxytricha,* &c., consisting of a mostly funnel-shaped tube, often lined with cilia.

A coloured gastric juice has been described by Ehrenberg as existing in the gastric cavities. The colour, however, has been accounted for by Siebold as produced by refraction and the presence of aggregations of pigment-granules, mistaken for gastric cavities. This explanation we believe to be inadmissible; and in some instances, at least (Pl. 23. fig. 19), the reddish-violet colour is real, and arises from the presence of solution of the colouring-matter of *Oscillatoriæ,* which is often different by reflected and transmitted light.

The particles of solid matter forming the food of the Infusoria, are usually drawn to the oral orifice by the action of the cilia. The manner in which *Actinophrys* takes its food is described under that head; but, from

Lachmann's observations, the rays of *Acineta* are hollow suctorial organs.

Circulating system.—On closely watching almost any of the Infusoria, minute, mostly rounded, clear spots are seen in the substance of the body, disappearing and reappearing at pretty regular intervals. These are of variable size, but about that of the gastric cavities. The nature of their contents, which is a colourless liquid, is doubtful. Dujardin regards it as consisting of water, and as existing in vacuoles similar to the vacuoles or gastric cavities; whilst Siebold and others find here a kind of rudimentary circulation of a nutritive fluid, comparable to the circulation of the blood. In certain Infusoria, as *Paramecium* (Pl. 24. fig. 56), this phenomenon is observed to take place between a central rounded and several elongated and radiating cavities, and the liquid contents are seen to be propelled from the former into the latter, and *vice versâ.* These contractile or pulsating vesicles or spaces, as they are called, never contain foreign particles; they are tolerably constant in position in the same species of Infusoria; and they do not rotate nor move like the gastric cavities; all which facts are opposed to the notion of identity with the latter. The contracting vesicles of some species open externally through a canal; and in others a long internal vessel is continuous with them. They are found in some Algæ, as *Volvox, Chlamidomonas, Gonium, Syncrypta*, in *Dinobryon*, and *Euglena*, which would negative their relation to an animal circulation. Lieberkühn and Lachmann describe distinct vascular branches arising from the contractile vesicles, not penetrating the internal sarcode of the body.

Another kind of circulation takes place in some of the larger Infusoria. This is a rotation of the mass of the internal substance of the body. It has been observed in *Paramecium*, but only in those specimens having green corpuscles imbedded in the outer coat.

When almost any of the Infusoria are allowed to remain upon a slide until most of the water has evaporated, rounded and somewhat highly refractive globules will become evident at their margins (Pl. 25. fig. 2 *a*); these consist of the semifluid gelatinous sarcode forming the interior of the body, and they possess a remarkable tendency to the formation of vacuoles or cavities within them, which apparently become filled with the surrounding water. This fact is perhaps the strongest in favour of the formation of the gastric cavities and contractile vesicles within the body of the living animals in the same manner as supposed by M. Dujardin, which, however, is opposed, in the case of the contractile vesicles, by their tolerably constantly uniform position, and especially their remarkable form (as in the stellate vesicles of *Paramecium* &c., Pl. 24. fig. 56), and the manner in which the contents in the latter instance are propelled from one to the other, or from the radiate to the rounded vesicles.

Nucleus (*ovarium*).—In the substance of the bodies of most of the Infusoria may be perceived a solid granular-looking body, of variable form, mostly rounded, elongate, or curved (Pl. 23. fig. 55; Pl. 24. figs. 37, 56; Pl. 25. fig. 26), sometimes branched (Pl. 25. fig. 25), which those who regard the Infusoria as consisting of simple cells consider a true nucleus, whilst Ehrenberg regarded it as a testis. The latter it certainly is not; but it is connected with reproduction, as stated below.

Nucleolus (*seminal body*).—This is usually a small body in or upon the nucleus, and which has a strong refractive power. It increases in size during conjugation, and plays a most important part in the sexual reproduction.

Propagation and reproduction.—The Infusoria increase in numbers by the following methods:—1. Fission or self-division. This occurs in (*a*) the perfect form of the animalcule, and (*b*) after it has become encysted. 2. Gemmation or budding. 3. Sexual reproduction. Metamorphosis takes place very frequently; and it is now admitted that no satisfactory observations have been offered in proof of the occurrence of the alternation of generations amongst the true Infusoria.

1. *Fission or self-division.*—(*a.*) Spontaneous division is either longitudinal (Pl. 25. fig. 37) or transverse (fig. 38). In both, the nucleus undergoes division, as well as the body. In the longitudinal division the process commences at one end of the body, from which the cilia usually are retracted or disappear; a notch is first perceived, which afterwards becomes deeper, until the body is completely cleft; the two halves then acquire cilia, and assume the functions of perfect animals. In the transverse division, a median constriction appears first, followed by perfect separation, as in the

last. During these processes of division, the animals sometimes continue their movements as usual; at others this is more or less interfered with. In *Vorticella* (Pl. 25. fig. 21 *a*), in which the process of longitudinal division may be conveniently watched on account of the comparative fixure of the animals by a pedicel, when the division is nearly completed a ring of cilia is formed near the attached end of the body, by the movements of which the new *Vorticella* is separated from the parent. The process is completed in about an hour.

Claparède and Lachmann state that the first process in the spontaneous division of *Vorticella* is the development of a fresh mouth-circle of cilia and a second contractile vesicle; then a partial division occurs, which is followed by fission of the nucleus and final separation of the two animalcules.

(*b.*) *Fission as part of an encysting process.*—Many of the Infusoria are observed to alter their form at certain periods, become rounded, lose or retract their cilia (Pl. 25. fig. 27), and to secrete all over their surface gelatinous matter, forming a coat or cyst enclosing them. While thus encysted, the substance of the body becomes divided, and gives origin to a number of individuals, which are discharged by the bursting of the cyst (Pl. 25. fig. 34). They do not then resemble the parent, but are gradually developed, during ordinary growth, into its form. In some cases the progeny or brood become individually encysted within the parent cyst; it appears, however, that they are not discharged in this condition, but escape first from their own cyst and then from the parent, in which they leave their own exuviæ. Stein thinks that it was such broods that Ehrenberg mistook for the results of the increase by diffluence.

In *Trichoda lynceus* the encysting process appears subservient to a kind of metamorphosis of the individual, the animalcule which emerges from the cyst having characters in many respects different from the *Trichoda*, but no multiplication is effected either by subdivision or gemmation. The late M. Jules Haime described this multiplication by fission, the encysting of ova of the separate *Trichoda*, and the subsequent escape of a differently shaped creature, which became gradually developed into a form like *Aspidisca*.

2. *Gemmation* is not a general process in the Infusoria. It is well seen in *Vorticella* (Pl. 25. fig. 26). The buds arise from near the posterior end of the body, and, when fully developed, liberate themselves by the formation of a posterior ring of cilia, as above mentioned.

3. *Sexual reproduction.*—Balbiani has shown that male and female organs are combined in each individual of the numerous genera he has examined, but that the congress of two individuals is necessary for the impregnation of the ova, those of each being fertilized by the spermatozoa of the other. The *ovarium* (or aggregation of germ-cells) is that organ which has been described by many observers as the "nucleus," whilst the *testis* (or aggregation of sperm-cells) is that which has been described as the "nucleolus." The development of each of these organs commences as a single minute cell, which usually multiplies itself in the usual way by subdivision; and when this has proceeded to a certain point, the cells of the *ovarium* become converted into *ova*, whilst those of the *testis* develop spermatozoa in their interior. The particular form and position which these organs present, and the nature of the changes which they undergo, vary in the several types of the Infusoria; but we have in the common *Paramecium aurelia* an example which, although exceptional in some particulars, affords peculiar facilities for the observation of the process. *Paramecium aurelia* multiplies to a great extent by self-fission, but only to a definite extent, for sooner or later they unite in sexual congress. They assemble upon certain parts of their containing vessel, and soon become coupled in pairs. They are closely adherent to each other, with their similar extremities turned in the same direction and their mouths closely applied. The freely swimming animalcules like *Paramecium*, while thus conjugated, continue moving with agility in the liquid, turning constantly round and round upon their axes; but those which, little *Stentor*, are attached by a footstalk remain almost motionless. The conjugation lasts for five or six days, during which period very important changes take place in the condition of the reproductive organs. Each individual contains an *ovarium*, which has at first a smooth surface, from which proceeds an excretory canal or oviduct that opens externally at about the middle of the length of the body into the buccal fissure, or so-called mouth. Each individual also contains a seminal capsule (the nucleolus), in which is seen lying a bundle of sperma-

tozoa curved upon itself, and which communicates by an elongated neck with the orifice of the excretory canal. The next process is the lobulation of the *ovarium*, incident on the development of separate ova, and the division of the spermatic capsule into two or four secondary capsules, each of which contains a bundle of spermatozoa now lengthened out. The four capsules commence to subdivide, and the ovarium begins to break up into fragments, which are connected with the excretory canal; and then the object of the conjugation is effected by the passage of the seminal capsules of each individual, previously to their complete maturation, into the body of the other. Ten hours after the conclusion of the conjugation, the ovarium will be found broken up into separate granular masses, of which some remain unchanged, whilst others, either two, four, or eight in number, are converted into *ova* that appear to be fertilized by the escape of the spermatozoa from the seminal capsules, these being now in process of withering. Three days after the end of conjugation four complete ova were seen within the connecting tube, whilst the seminal capsules had quite disappeared. The development of these ova after their escape has not been followed out; but those of species in which the prior impregnation has not been seen have been carefully examined at different stages of their growth.

The metamorphosis of the Infusoria has been noticed above; and it is now necessary to explain that there is another method by which the individual is preserved for a while, the *encysting process without fission.* Many Infusoria at certain times undergo an *encysting process*, which apparently serves as a provision under circumstances which do not permit the continuance of their ordinary vital activity. The movements of the Infusoria diminish in vivacity, and the cilia are either lost or retracted; the surface of the body exudes a secretion which hardens around it, and the animalcule lives on and rotates within its cyst until the time for its escape arrives.

Some observers have attempted to prove that Infusorial animals and plants are derived from the direct transformation of organic matters; thus the molecules of the ultimate fibrillæ of muscle, when separated by the effect of decomposition, acquire the appearance and motion of *Bacteria.* These observations, however, prove nothing to the point, because the bodies are so much alike as to be undistinguishable by mere appearance and without the use of chemical reagents. These have been entirely neglected. Repetition of the experiments with the aid of acetic acid and solution of potash, shows readily that these notions are entirely erroneous.

Some Infusoria live in very briny water; and a few can exist at a temperature of 120°Fahr.; but their numbers diminish with the cold of winter, although a few can exist when frozen in ice. Hardy as they are as a class, it is therefore very remarkable to witness the succession and disappearance of different genera during a comparatively short time in infusions and natural waters.

Diffusion, &c.—When we consider that the multiplication of the Infusoria by division takes place according to a geometrical progression, also that they need only become encysted to produce swarms of germs, we can easily understand their rapid propagation in liquids; when also they will resist a degree of cold =8° F., and an elevated temperature of 260° F., or even desiccation, without destruction, and when their minute size is added, we can readily understand their almost universal diffusion.

As we have stated, a drop of water can scarcely be found which does not contain some Infusoria. Many of them will only live in fresh or sweet water, whilst others are found only in decomposing and even putrid water containing decomposing animal and vegetable substances; others, again, are only met with in salt or brackish water. Those existing in fresh water may be collected in ordinary wide-mouthed bottles, a drop of which may be removed by the dipping-tube; any individual one perceptible to the eye may be withdrawn by the same means. Their natural movements are best watched in the live-box; but these movements greatly interfere with the observance of the contractile vesicles and general minute structure, which is best seen when they are simply confined between the slide and cover, in a small quantity of water. A good plan for arresting their motions is that of warming the slide containing them over a candle or lamp for a short time. Many Infusoria live only in particular kinds of infusions, just as certain plants live only upon particular kinds of soil; and these infusions should be prepared by adding cold fresh water to the vegetable or animal substances (the water

being in considerable excess), and allowing the mixture to remain for a time. Even in infusions of many powerful poisons, as of Nux vomica, Cevadilla, &c., they will not be found absent; and Dujardin has noticed that their development is greatly promoted by the addition of certain salts to the solutions, as phosphate and carbonate of soda, phosphate, nitrate, and oxalate of ammonia; and this author is inclined to believe that some of these salts become decomposed in the presence of the organic matters, yielding nitrogen to the Infusoria; he also states that oxalate of ammonia disappears entirely under these circumstances. We believe, however, that a process of oxidation goes on in many of these cases, unconnected with the presence of the Infusoria, and thus salts of vegetable acids become converted into salts of more highly oxidized acids, as into carbonates, &c. Finally, some live as parasites.

The following are the most common of the Infusoria found in natural waters or infusions of vegetable or animal matters:—

Amphileptus fasciola.
Bodo saltans.
—— *socialis.*
Chilodon cucullulus.
Chilomonas paramecium.
Chlamidomonas pulvisculus.
Coleps hirtus.
Colpoda cucullus.
Cyclidium glaucoma.
Euplotes charon.
Glaucoma scintillans.
Leucophrys carnium.
—— *pyriformis.*
Monas crepusculum.
—— *gliscens.*
Monas guttula.
—— *termo.*
Oxytricha pellionella.
Paramecium aurelia.
—— *chrysalis.*
—— *colpoda.*
—— *milium.*
Polytoma uvella.
Stylonichia pustulata.
—— *mytilus.*
Trachelius lamella.
Trichoda pura.
Trichodina grandinella.
Uvella glaucoma.
Vorticella convallaria.
—— *microstoma.*

Some of the Infusoria are phosphorescent, and impart a luminous property to sea-water. The following are the species in which this has been distinctly observed:—*Prorocentrum micans*; *Peridinium michaelis*, *P. micans*, *P. fusus*, *P. furca*, and *P. acuminatum*; *Synchæta baltica*, and a doubtful species of *Stentor*.

Slender needle-like crystals of sulphate of lime have been observed affixed to the bodies of the Infusoria, probably derived from the water in which they live.

The Infusoria are difficult of preservation. Some of them will exhibit their characters when dried—the cilia and vacuoles remaining very distinct, as also the striæ upon the integument. Others are but little changed by a concentrated solution of chloride of calcium. Solution of chromic acid or of bichloride of mercury will answer with some of them, although they are rendered somewhat opaque by these reagents, which is sometimes an advantage where they are naturally very transparent.

The systematic arrangement of the Infusoria is in an unsettled state. The characters of the genera and species laid down by Ehrenberg are mostly founded upon analogies more than upon observation. Those proposed by Dujardin, on the other hand, are far more accordant with observation, and consequently more simple and practical. But unfortunately the latter author has so altered the names proposed by Ehrenberg, and since generally adopted—raking up old and long-forgotten names, which are moreover often doubtfully identical with those for which they are substituted, and sometimes using similar names for totally different genera and species—that great confusion has been produced, and the two systems are not at present reconcilable.

In descriptions of genera and species the anterior part of the body is that near which the eye-specks are situated, and which is directed forwards; the surface towards which the eye-specks are nearest forms the back or dorsal surface. A narrowing of the body posteriorly, so as to give rise to a prolongation, forms a tail; and an anterior prolongation of the dorsal surface is described as a forehead or upper lip, according to its situation.

According to Dujardin's system, the Infusoria are arranged as follows (excluding those certainly belonging to the Algæ).

Body unsymmetrical, or not composed of two similar lateral portions.

Sect. 1. Furnished with variable expansions.

* Expansions visibly contractile, simple, or frequently branched.

Fam. 1. Amœbæa. Naked, creeping, incessantly changing their form.

Fam. 2. Rhizopoda. Creeping or fixed; secreting a more or less regular shell or carapace, from which incessantly changing expansions are exserted (*Arcellina*, Ehr.).

** Expansions very slowly contractile, always simple.

Fam. 3. Actinophryina. Animals almost immovable (*Acinetina*, Ehr.).

Sect. 2. Furnished with one or more flagelliform filaments which serve as locomotive organs; no mouth.

* No integument.

Fam. 4. Monadina. Swimming or fixed.

** With an integument.

♀. Aggregate. Floating or fixed.

Fam. 5. Dinobryina. Teguments connected at one point, forming a branched polypidom.

♀ ♀. Isolated. Swimming.

Fam. 6. Thecamonadina. Tegument not contractile (*Cryptomonadina* and some *Astasiæa*, Ehr.).

Fam. 7. Euglenia. Tegument contractile (*Astasiæa*, pt. Ehrenb.).

Fam. 8. Peridinæa. Tegument not contractile, a furrow occupied by vibratile cilia.

Sect. 3. Furnished with cilia, no contractile tegument. Swimming.

* Naked.

Fam. 9. Enchelia. No mouth; cilia scattered without order (not *Enchelia*, Ehr.).

Fam. 10. Trichodina. Mouth visible or indicated by an oblique row, or oral ring of cilia; no cirri.

Fam. 11. Keronia. Mouth present; an oblique row of cilia, with cirri or stouter cilia in the form of styles or hooks.

** With a carapace.

Fam. 12. Plœsconina. Carapace diffluent, or decomposable like the rest of the body.

Fam. 13. Ervilina. Carapace true, persistent. A short pedicle.

Sect. 4. Ciliated; furnished with a lax, reticular, contractile tegument, or the presence of a tegument indicated by the regular serial arrangement of the cilia.

* Always free.

Fam. 14. Leucophryina. No mouth.

Fam. 15. Paramecia. With a mouth, no oral fringe of cilia.

Fam. 16. Bursarina. A mouth and an oral fringe of cilia.

** Fixed, either voluntarily, or by their organs.

Fam. 17. Urceolarina. Fixed voluntarily.

Fam. 18. Vorticellina. Fixed, at least temporarily, by their organs or by some part of the body.

Symmetrical Infusoria.

* Several types having no relation with each other.

Gen.: *Planariola.* *Coleps.* *Chætonotus—Ichthydium.*

Claparède and Lachmann have given a classification (1868) which, although incomplete, is much more natural, and in accordance with the advancing knowledge of the age than any others. Whilst protesting against the summary relegation of many forms which formerly were considered to be ciliated Infusoria to the Algæ, they leave the question of the classification and definition of the Flagellate Infusoria still open.

Their order Ciliata is well defined; and the general anatomy of its members has been described in this article.

The Opalina are not included amongst the Infusoria.

The Acinetina (see Acinetina), with their retractile suckers, these authors con-

The following is the classification of MM. Ed. Claparède and J. Lachmann (1868):—

INFUSORIA	Without a flagellum	Cilia or bristles even in the adult form No suckers	Order I. CILIATA.
		No cilia in the adult form Suckers present	Order II. SUCTORIA.
	One or more flagella	Flagellum (one or more) and cilia present	Order III. CILIO-FLAGELLATA.
		No cilia	Order IV. FLAGELLATA.

Order I. Ciliata.

CILIATA	1. Mouth and œsophagus open, in repose, the latter ciliated, neither dilatable	Mouth and anus in a common fossa. Buccal spiral dexiotrope				1. Fam. *Vorticellina*.
		Mouth and anus not in a common fossa. Buccal spiral læotrope	Body without cilia, except the buccal cirri	No other locomotive organs than the buccal cilia		2. Fam. *Urocentrina*.
				Crawling locomotion		3. Fam. *Oxytrichina*.
			Body covered with cilia	Body bell-shaped, several rows of buccal cilia		4. Fam. *Tintinnodea*.
				Buccal spiral, when it exists, only forming one turn	Buccal spiral of cirri stronger than the cilia of the surface	5. Fam. *Bursarina*.
					No buccal spiral	6. Fam. *Colpodea*.
	2. Mouth and œsophagus very dilatable. Œsophagus not ciliated	Body entirely or mostly ciliated	A foot			7. Fam. *Dysterina*.
			No foot	No cuirass		8. Fam. *Trachelina*.
				A cuirass		9. Fam. *Colepina*.
		Body glabrous, and one row of cilia around the mouth				10. Fam. *Halterina*.

Order II. Suctoria. The ACINETINA.

ACINETINA	Suckers not placed on a proboscis or tube	Suckers not branched	Not forming a branched colony	No sheath	A peduncle		1. Genus *Podophrya*.
					No peduncle	Free	2. Genus *Sphærophrya*.
						Fixed	3. Genus *Trichophrya*.
				A sheath	A peduncle		4. Genus *Acineta*.
					No peduncle		5. Genus *Solenophrya*.
			Forming branched colonies				6. Genus *Dendrosoma*.
		Suckers ramified					7. Genus *Dendrocometes*.
	Suckers carried on a long retractile tube						8. Genus *Ophryodendron*.

Order III. Cilio-flagellata. PERIDININA.

PERIDININA	A transverse groove	The two portions of the cuirass equal in length	Cuirass with prolongations	1. Genus *Ceratium*.
			Cuirass without appendages	2. Genus *Peridinium*.
		The two portions unequal	Borders of the notch turned up and lamelliform	3. Genus *Dinophysis*.
			Borders not turned up	4. Genus *Amphidinium*.
	No groove. Cilia on the anterior margin			5. Genus *Prorocentrum*.

This classification is incomplete so far as the naked *Peridinina* and the Flagellata are concerned.

sider to be a very isolated group, and that they are only allied to any other through *Syncrypta volvox*, Ehr., which has a flagellum as well as suckers and therefore allies them to the Flagellata. The Acinetina retain any animalcule which touches their suckers, kill it, and transfer its juices to their own sarcode. The contractile vesicles are numerous in some species; and the nucleus (ovarium) is usually visible. Embryos which are ciliated are visible at certain times within the Acinetina, and they escape as free swimmers to lose these locomotive organs during growth and development.

The Cilio-flagellata connect the Ciliata with the Flagellata: and here the debatable ground is fairly entered; for Leuckhart considered them to be Algæ, and Ehrenberg mixed up with them some so-called Flagellata which are in all probability of really vegetable origin. The Cilio-flagellata are mostly cuirassed, and have, besides cilia, one or more retractile flagella; but there are many without a cuirass, and they are comparatively unexamined. It is evident that the contractile vesicles are not present in this order, although nuclei (ovaria) are. Bailey considers them to be embryonic Annelidans, but the presence of the cuirass presents a difficulty to this view.

The Flagellata are not classified by Claparède and Lachmann; but it is evident throughout their essays that they are very undecided how to grapple with this group, or rather collection, of very different beings possessing a flagellum and no cilia. Many cells of the Spongida, of cellular plants, and Rhizopoda are associated together in, at present, a most unsatisfactory manner in this group; and Prof. Clark allies them with the Spongida, showing how *Monas*, *Anthophysa*, *Astasia*, &c. resemble the monociliated sponge-cells described by Carter. It constitutes the 2nd section of the 3rd family of Dujardin, and Pritchard's Phytozoa.

Bibl. Müller, *Animalc. infusoria*, 1786; Ehr. *Die Infusionsth.*; Dujardin, *Infusoires*, 1841; Pineau, *Ann. des Sc. Nat.*, *Zool.* 3 sér. iii. v. ix.; Stein, *Die Infusionsthiere*, Leipsic, 1854; Focke, *Isis*, 1836, and *Physiolog. Studien*; Meyen, *Müller's Archiv*, 1839; Pritchard, *Infusoria*; R. Jones, *Ann. Nat. Hist.* 1839, iii.; Erdl, *Müller's Archiv*, 1841; Griffith, *Ann. Nat. Hist.* 1843, xii.; Siebold, *Lehrb. d. vergl. Anat.*; Cohn, *Sieb. u. Köll. Zeitschr.* iii. 260; Kölliker, *Sieb. und Kölliker's Zeitschr.* i. 198; Claparède and Lachmann, *Etudes*, Genève, 1868; Engelmann, *Natur. des Infus.* 1862; Balbiani, *Jour. de la Phys. Brown-Sequard*, 1861; Jules Haime, *Ann. des Sci. Nat.* s. 3. t. xix. p. 109; Stein, *Der Org. d. Inf.* 1859, 1866, 1867; Clark, *Boston Mem. N. H.* 1866; Balbiani, *Sexual Organs of Infusoria*, *Q. M. J.* 1862, pp. 176, 285; *Ann. N. H.* 1858, i. 435; Perty, *Die kleinsten Lebensformen, &c.* (several new genera and species), Bern, 1852; Cienkowski, *Qu. Mic. Jn.* v. 96; Lieberkühn, *Ann. Nat. Hist.* 1856, xviii. 319; Carter, *ibid.* xviii. 115; Huxley, *On Dysteria*, *Q. J. Mic. Sc.* 1857; Gosse, *Qu. Journ. Mic. S.* 1857; Ray Lankester, *Papers in Qu. Journ. Mic. Sci.*

INFUSORIAL EARTH.—Composed of Rhizopodal remains, the loricæ of Diatomaceæ and Desmidiæ. Richmond, Virginia, Barbadoes, Tripoli, Mull, Sweden, Bilin.

INJECTION.—The art of filling the vessels and other minute tubular organs of animals with coloured substances, by which their relative size, arrangement, and relation to the surrounding parts may be made manifest. The substances used for injections consist of powders, mostly insoluble, mixed with some liquid which holds them in suspension or solution; and while in this state they are driven into the vessels by a syringe or some similar contrivance. We shall first give a sketch of the apparatus requisite, and the method of making the liquids for injecting the tissues of the Vertebrata, before treating of the process itself.

Syringe.—Two or three syringes are requisite, of various sizes, adapted to the volume of injection to be thrown into the vessels, or the size of the animal or part to be injected. In general, one holding 6 drms. or 1 oz., and another holding about 2 oz. will be found the most useful. Each syringe must be provided with two rings at the upper part next the handle, so that it may be firmly and easily held. The syringes when in use should be surrounded by a roll or two of flannel fastened with string, to prevent their rapid cooling; and the flannel should be kept as dry as possible during the process.

Sometimes a much smaller syringe, called an oyster-syringe, is useful for injecting very small and soft animals.

The plug of the piston is adapted to the tube of the syringe by two pieces of wash-leather, the method of replacing which must be learnt at the time the syringe is bought,

for it is difficult of description. The plug must work air-tight in the tube, which may be proved by depressing the handle as far as possible, then closing the nozzle of the syringe with one finger, withdrawing the handle to its fullest extent, and letting it go, when it should fly entirely home. If this does not take place, the plug must be releathered.

The handle of the syringe should be graduated; *i. e.* transverse lines should be scratched upon it with the end of a file, or in some other way, so that when its descending movement is so slow as not to be felt by the hand, it may be indicated to the eye.

The syringes, and in fact all the mechanical apparatus requisite for injection, may be purchased of Mr. Neeves, Regent Square, or of Mr. Ferguson, Giltspur Street, Smithfield.

The syringe must accurately fit the stopcocks and pipes.

Injecting-pipes.—These must be of various sizes, to suit those of the vessels into which they are to be introduced; they are furnished with two short transverse arms, by which they may be tied to the vessel. The smallest pipes which are made easily become stopped up unless thoroughly cleansed after use; to remove any obstruction, a very fine "broach" needle made of watch-spring is required, and may be procured of Mr. Ferguson as above.

Stopcocks.—One or two of these are useful in stopping the injection from returning, when the syringe is removed, or force ceases to be applied to it.

Forceps.—One or two pairs of small tenaculum forceps must be at hand; these are noticed in the INTRODUCTION, p. xxii.

Jars or other vessels for holding the injection. These may consist of confectioners' jam-pots, or may be made of tin. The former have the advantage of retaining the heat for a considerable time. When in use, the jars must be placed in a water-bath, or in a tin vessel containing water, and placed over a stove.

Stirring-rods.—These must be made of wood.

Size.—The colouring-matters used for injection are mostly insoluble powders. These are usually mixed with size or some form of solution of gelatine, which holds them in suspension better than water. The author of the application of this substance to injecting-purposes we believe to be Mr. Goadby; and very valuable it is.

The size mostly used is that termed Young's patent size, and it is sold in the shops. It should be clear and fresh. Those who cannot obtain this may prepare its equivalent by dissolving 1 part of glue in 8 or 10 parts of water with the aid of heat.

The principal liquid injections used may be arranged according to their colours. In regard to the proportions of the colouring-matter to that of the size, it must be remarked that these vary as used by different injectors, and that, in general, when the vessels to be injected are very minute the size should be somewhat thinner, and the proportion of pigment rather less, than under the opposite conditions. When the injection is directed to be strained, this must be done through a piece of new flannel wrung out of hot water, or through a "tammy sieve," which is more convenient. In preparing the injections, great care must be taken that the jars are perfectly clean, and that no old injection remains adherent to them. The colouring-matters, whether dry or dissolved, should be added to the size previously warmed in the water-bath, or the tin vessel mentioned above; and the whole should be stirred until thoroughly incorporated. When trituration is spoken of, it must be understood that the rubbing in a mortar should be continued for a long time, until the substance is reduced to the finest possible state of powder.

Harting recommends preparing a stronger size than that mentioned above, containing 1 part of glue to 4 of water, and that the chemical substances be dissolved in the additional water requisite before being added to the size, which would seem to be preferable; but we have found the method recommended to answer every purpose, and it has the advantage of greater simplicity.

Red Injection.—This is best made with vermilion (bisulphuret of mercury), which before use should be carefully examined as to its purity from minute colourless crystalline particles, by viewing it by reflected light, when they are easily detected. When the vessels to be injected are very minute, the vermilion is best previously levigated, *i. e.* triturated in a mortar with a small quantity of water, the whole being afterwards thrown into a large amount of water, and allowed to settle for a few seconds, so that the coarser particles still left may subside; the upper portions of the liquid, containing the finer parts of the powder, are then poured off and allowed to settle, the

supernatant water being again poured off, and either allowed to dry slowly, or mixed while moist with the size.

The ordinury proportions for this injection are:—

Vermilion $1\frac{1}{2}$ oz. } (Avoirdupois weight).
Size .... 1 lb. }

or

Vermilion 164 grs. (Apoth. wt.)
Size .... 4 oz. (Avoird. wt.)

Stir the colouring-matter well with the warmed size, then strain.

Other red colouring-matters have been used, but they cannot be recommended. Among them may be mentioned:—the basic chromate of lead, prepared by boiling the neutral chromate with caustic or carbonate of potash; the biniodide of mercury, formed by decomposing bichloride of mercury with iodide of potassium in atomic proportions; the oxysulphuret of antimony; solution of carmine in ammonia.

Yellow Injection.—This is prepared with the chromate of lead (chrome-yellow), as follows:—

Take of

Acetate of lead	380 grs.
Bichromate of potash..	152 grs.
Size................	8 oz.

Dissolve the lead-salt in the warm size, then add the finely powdered bichromate of potash.

As thus prepared, some of the chromic acid remains free, and is wasted, which may be obviated by preparing the chromate of lead with the chromate of potash in the proportions of

Acetate of lead............	190 grs.
Chromate of potash (neutral)	100 grs.
Size	4 oz.

or

Acetate of lead	196 grs.
Bichromate of potash	76 grs.
Carbonate of potash........	41 grs.
Size	4 oz.

The chromate of lead prepared from the bichromate of potash alone has the deepest colour, and is that generally used.

No better yellow injection than this can be found, or is requisite.

White Injection.—The best white injection is made with carbonate of lead, thus: take of

Acetate of lead	190 grs.
Carbonate of potash	83 grs.
Size	4 oz.

Dissolve the acetate of lead in the warm size and filter; dissolve the carbonate of potash in the smallest possible quantity of water, and mix it with the size.

143 grains of carbonate of soda may be substituted for the above amount of carbonate of potash.

A white injection (very inferior) may also be made with carbonate of lime, by taking of

Fused chloride of calcium ..	111 grs.
Carbonate of potash........	167 grs.
Size	4 oz.

286 grs. of carbonate of soda may be substituted for the carbonate of potash.

Blue Injection.—In whatever manner prepared, this cannot be in general recommended; for blue pigments reflect so little light, that the injections made with them appear almost black. The only one worthy of mention is prussian blue suspended in oxalic acid, which may be prepared with

Prussian blue	73 grs.
Oxalic acid	73 grs.
Size	4 oz.,

the oxalic acid being first finely triturated in a mortar, the prussian blue and a little water afterwards added, and the whole then thoroughly mixed with the previously warmed size.

General method.—When the part for injection has been selected, the first proceeding is to fix the pipe in some vessel; and the larger this is, the more easily will the pipe be inserted and fixed. When the vessel has been isolated, if it has been cut across, the pipe should be introduced at its end, pushed up as far as possible, and a piece of not too thin silk thread passed beneath and tied around it, enclosing of course the nozzle of the pipe; the ends of the silk should then be wound round the arms of the pipe and again tied, so that the pipe may remain firmly fixed in the vessel. If the vessel be not divided, a longitudinal slit should be made in it for the introduction of the pipe, the thread being passed round it by a curved needle, the eye of which carries the thread. As soon as the pipe has been fixed in the vessel, all other vessels communicating with it should be tied round with silk thread or closed in some other way, that the injection may not escape: sometimes it is requisite to enclose a part of the tissue itself in the ligature; in other instances their closure may be effected by fusion of

the tissue at the spot from which the injection might escape, by the application of a red-hot iron.

The organ or part to be injected is then immersed in warm water, in order that it may become heated throughout; and if it be large and of considerable thickness, this may take some time; and fresh warm water must be added at intervals to keep it at the same temperature, which should be about as great as can be borne by the hand. If the water be too hot, the vessels and tissues will be rendered brittle, and the whole will be spoiled. Moreover the part should not be kept longer in the water than is absolutely requisite, for the same reason. While the tissue is becoming heated in the water, the injection should be prepared, or be heated if previously prepared, and kept constantly stirred; the stopcocks should also be immersed in hot water.

As soon as all is ready, the stopcock turned open is fixed to the syringe, and some hot water is drawn into and expelled from the syringe two or three times, so that it may become properly heated. It is next filled with the injection, taking especial care that no air be allowed to enter, to avoid which it must be filled, emptied, and refilled several times, the nozzle being kept beneath the surface of the injection. The syringe is then taken in the hand, a little of the injection being forced out at the nozzle of the stopcock, which is next loosely inserted into the pipe; and some of the injection being urged into it by depressing the handle, the pipe is filled, and the nozzle introduced into it. Very gentle pressure is then made upon the piston, so that the injection may be driven into the vessels; and this must be continued until the piston ceases to be felt to move, or is seen not to enter the syringe further, by watching the graduations on its handle. When this is found to be the case, firmer pressure must be made and the effect noticed. But practice can alone guide as to the time at which the pressure should cease, or when as much injection has been forced into the preparation as is required. Some judgment may be made from the colour assumed by the preparation; or, the stopcock being turned off, and the syringe separated from it, the preparation may be examined with a low power, while laid upon a large glass plate.

During the continuance of the process, the preparation, the injection, and the pipes must be kept at the original temperature; and should any part be found to become cool, the stopcock must be turned off, the syringe separated, the injection returned to the jar, fresh warm water added to the preparation, and the whole process recommenced as at first.

If, during the process, there should be an escape of the injection from any part, this need not cause alarm if slight; should it, however, be considerable, it must be stopped by one of the means pointed out above—perhaps by the orifice of the vessel and surrounding parts being grasped by the tenaculum-forceps, and the whole included in a ligature. If the preparation be small, notwithstanding a considerable escape of the liquid, a very good injection may often be made.

As soon as the injection is completed, a ligature should be placed around the vessel into which the pipe is inserted, beyond its nozzle; the pipe is next removed, and the preparation should be immersed in clean cold water, and kept in it for an hour or two at least. It may then be withdrawn and sections made of it with a knife, razor, or some other instrument.

Large pieces of injected preparations are best preserved in a stoppered bottle containing dilute spirit of wine (1 spirit to 2 water, or equal parts). See also MOUNTING and PRESERVATION.

When two or more sets of vessels are to be injected, the process should be continued uninterruptedly until completed; *i.e.* as soon as the injection of one set has been completed, another pipe should be at once inserted into one of the other set, and so on. Or what is better, if possible, the pipes for the two or three sets should be introduced and fixed at once, before the process is commenced.

As regards the period after death at which the injection should be commenced, this varies with the kind of organ or tissue: if it be delicate, the sooner the better; whilst if the vessels be comparatively large, by some little delay the tissue becomes somewhat softer and more yielding.

When a tissue has been successfully injected, the vessels appear plump and well filled by reflected light. But if they are not so, the preparation has its value; for it will perhaps well display the relative positions of the capillaries to the surrounding tissues when viewed by transmitted light—often even better than when the injection has been what is termed successful. In fact,

when the vessels are well filled, little more can be seen in general than the relative situation of the vessels to each other.

The choice of the kind of injection is not a matter of much importance, except as regards the facility with which the vessels are traversed. The arteries are in general filled with red injection, the veins with yellow, and the ducts (as the urinary tubules) with white. The chromate of lead is perhaps the finest injection and runs best, except that made with prussian blue and oxalic acid, which does not reflect enough light where the vessels are to be viewed by reflected light, although when these are very minute and can be conveniently viewed by transmitted light it may be preferred.

It may be remarked that, if it be required to use a yellow (the chromate) injection and a white (the carbonate of lead) for two sets of vessels in one preparation, the chromic acid in the former must previously be completely neutralized; otherwise it will render the white (carbonate of lead) yellow. This may, however, be avoided by substituting the carbonate of lime for that of lead.

As microscopic objects, nothing can exceed the beauty of injected preparations; and to be seen in their greatest perfection they should be dried, moistened with oil of turpentine, and mounted in Canada balsam. At the same time it must not be forgotten that, when dried and preserved in this manner, the real arrangement of the vessels is more or less distorted, those lying in different planes being brought into the same, and so on.

In Plate 31. figs. 33, 34, and 35, we have given representations of three injections viewed by reflected light,—fig. 35 being taken from the liver of a cat, in which injection made with vermilion was thrown into the portal vein, and that with chromate of lead into the hepatic vein; fig. 34 is a portion of the lung of a toad injected with vermilion; and fig. 35 is a portion of the kidney of a pig, the arteries and Malpighian tufts (Kidney) being filled with the red (vermilion) injection, and the urinary tubules with the white (carbonate of lead).

The tissues of the Invertebrata are so soft, that the ordinary syringes and pipes can rarely be used for injecting them, and recourse must be had to a finer and lighter form of apparatus. One recommended by Rusconi consists of a kind of trochar, consisting of a needle and the quill of a crow, partridge, or some small bird. In using it, the small vessel through which the injection is to be thrown is held with forceps against the extremity of the trochar, and punctured with the needle. The quill is next directed into the puncture, and the needle withdrawn. The small nozzle of a syringe is then introduced into the upper end of the quill, and the injection thrown in. A form proposed by Harting consists of a common glass pipette of moderate width, and of a caoutchouc tube the smaller end of which is fastened by means of thread to the broader end of a fine, curved, glass nozzle. In using this apparatus, the pipette is first filled with the injection, and its lower portion introduced into the broader end of the caoutchouc tube, which, from its conical form, it accurately closes.

Automatic injecting was first introduced by Ludwig; and many methods have been employed to utilize the pressure of the atmosphere instead of the force of a syringe. The following is Rutherford's method:—A large jar of water attached to a pulley, so that it can be elevated to any height. A long elastic tube with a stopcock is connected with the interior of the jar, near its bottom, so that the water may flow out when required. The other end of this tube transmits the water into *b*, a large Woulfe's bottle having three apertures. The bottle contains air at the commencement. The water is permitted to flow in by one aperture, through a long glass tube which passes to the bottom of the bottle. The air is thereby driven out through the other two apertures, one communicating with (*c*) a mercurial manometer for indicating the pressure, the other transmitting the air through an elastic tube to *d*, a second Woulfe's bottle containing the injecting fluid. This bottle has two apertures. The air is forced upon the surface of the fluid, and a glass tube, reaching nearly to the bottom of the bottle, transmits the fluid thence to an elastic tube joined to a glass or metal nozzle placed in the artery. Any number of Woulfe's bottles corresponding to *d* may be added, so that different injecting fluids can be thrown in at the same time. The pressure can be regulated with the greatest nicety.

Different liquids for injection are also usually requisite; and many have been recommended. Among these may be mentioned:—1, indigo triturated with oil and diluted with oil of turpentine; 2, oil-paints diluted with oil of turpentine; 3, infusion

of logwood (*Hæmatoxylon*); 4, solution of carmine in size or in ammonia; and 5, solution of alkanet in turpentine.

A considerable escape of the injection is often unavoidable in these cases, and must therefore not be heeded.

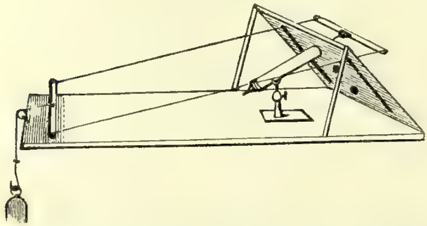
Some injectors simply introduce the injection into the dorsal vessel or lacunæ, whence it is propelled to all parts of the body by the circulation. Thus M. Agassiz says that if the indigo injection (1) be introduced in this way into insects, it is seen to circulate almost instantaneously in every part of the body, and on subsequently opening the insect all parts of the body are found to be coloured. We believe that M. Blanchard also adopts this method. Probably the best injections for this purpose would consist of alkanet and turpentine.

Self-injection occupies an important position amongst the various modes. The vascular system of the frog may be injected by inserting a pointed glass tube filled with the coloured injecting fluid into the vena cava. The fluid passes into the heart, and is distributed through the system by the force of the heart itself. The biliary vessels of living animals have been injected by means of colouring-matter introduced into the jugular veins.

Toldt has injected the lymphatics on this system; and he introduces a granular pigment (anilin) precipitated by water from its alcoholic solution into the blood.

The perfect injection of an organ or an entire animal of considerable size is a tedious and fatiguing process. We have therefore contrived a very simple piece of apparatus, which any one can prepare for himself, and which effects the object by mechanical means. It consists of a rectangular piece of board, 2′ long and 10″ wide, to one end of which is fastened an inclined

Fig. 360.



piece of wood supported by two props, as shown in fig. 360. The inclined portion is pierced with three holes, one placed above the other, into either of which the syringe may be placed—the uppermost being used for the larger, the lowermost for the smaller syringe; and these holes are of such size as freely to admit the syringe covered with flannel, but not to allow the rings to pass through them. The lower part of the syringe is supported upon a semiannular piece of wood, fastened to the upper end of an upright rod, which slides in a hollow cylinder fixed at its base to a small rectangular piece of wood; and by means of a horizontal wooden screw, the rod may be made to support the syringe at any height required. The handle of the syringe is let into a groove in a stout wooden rod connected by means of two catgut strings with a smaller rod, to the middle of which is fastened a string playing over a pulley, and at the end of which is a hook for supporting weights, the catgut strings passing through a longitudinal slit in the inclined piece of wood.

In use, the part to be injected is placed in a dish of some kind containing warm water, supported at a suitable height beneath the end of the syringe by blocks of wood. The syringe is then filled with injection, passed through the proper aperture in the inclined board, and fitted to the pipe, the stopcock being turned off. The rod and strings are next adjusted, and, a suitable weight being added, the stopcock is very slowly turned on, and the effect watched. If the handle of the syringe does not move, more weight must be added, the stopcock always being turned off when this is about to be done.

A great advantage of this apparatus is, that it sets at liberty the hands, so that an escape of injection may be arrested, or fresh warm water added, without interruption of the process.

When it is not required to fill the capillaries, but only the smaller arteries or veins, the colouring-matters need not be prepared by double decomposition, and the following substances may be used:—

Red.—Size 1 lb. (avoirdupois wt.), vermilion 2 oz. (avoird. wt.).
Yellow.—Size 1 lb., King's yellow (orpiment) or chrome-yellow, $2\frac{1}{2}$ oz.
White.—Size 1 lb., flake-white, $3\frac{1}{2}$ oz.
Blue.—Size 1 lb., fine blue smalt 6 oz.
Black.—Size 1 lb., lamp-black 1 oz.

Injections made with transparent solu-

tions are very valuable to the minute anatomist. Fine gelatine is usually employed, and is dissolved in water over a water-bath, the colouring-matter already in solution being then added, and the mass introduced into a Woulfe's bottle, which must be immersed in a warm water-bath. The injection takes long to do; and the warmth must be kept up. The colouring-matters usually employed are prussian blue and carmine—the latter not in a state of complete solution, but partly precipitated by the addition of a little weak acid from its alkaline solution. Stricker mentions that Thiersch, whose transparent injections are wonderful, uses a transparent green, and yellow,—the former from chromate of potash and nitrate of lead, and the latter from a mixture of this with blue. Beale, in order to avoid the injecting of warm fluids, uses colouring-matter, water, glycerine, and traces of hydrochloric acid; afterwards the injected mass is placed in absolute alcohol.

Carter's carmine injection:—

Dissolve 60 grains of pure carmine in 120 grains of Liq. Ammon. fort., and filter if necessary; mix with this $1\frac{1}{2}$ oz. of hot solution of gelatine (1 to 6 of water); mix another $\frac{1}{2}$ oz. of the gelatine solution with 86 minims of glacial acetic acid, and drop this little by little into the solution of carmine, stirring briskly the whole time. Dry or immerse, and harden in solution of chromic acid; cut with a sharp razor, and mount in Canada balsam.

Dr. Beale recommends for the finest injections the following:—Mix 10 drops of the Tinct. Ferri Perchlor. with 1 oz. of glycerine, and mix 3 grains of ferrocyanide of potassium, previously dissolved in a little water, with another 1 oz. of glycerine. Add the first solution to the second gradually, and shake; and lastly add 1 oz. of water and 3 drops of hydrochloric acid.

Injections may be preserved either in the dry or wet state. For the former, sections should be made, thoroughly dried upon slides, then moistened with oil of turpentine, and mounted in balsam. For preservation in the wet state they must be mounted in cells while immersed in dilute spirit, Goadby's B. solution, or in chloride of zinc (see MOUNTING and PRESERVATION).

We have not space to give a list of injected preparations; they are all very beautiful, but we can only notice a few of the most interesting. For practice in the art of injecting, we may reccommend the kidney of a sheep or pig,—one system of vessels being alone filled with red or yellow injection; and this should be the arterial. Afterwards, in another kidney, the urinary tubules may be injected first, with white injection, and subsequently the arteries with red or yellow. A portion of the small intestine, exhibiting the general capillaries, with the plexuses of the villi, forms a beautiful object as prepared from the rabbit, the rat, &c. Among other preparations may be mentioned:—the liver of various animals, as the cat, the rabbit, &c.; the lungs of the cat, rabbit, &c., in which the capillaries are very minute; those also of the reptiles, as of the frog, triton, boa, and other snakes, in which they are coarser, but very beautifully arranged; the lungs of birds; the kidneys of the frog and triton; the web of the frog's foot; the ciliary processes and choroid coat of the eye; the gills of the eel and other fishes; the lungs of kittens, &c., which have not breathed, the air-cells being injected from the trachea; the skin of the frog, and especially of the triton, &c.

BIBL. Tulk and Henfrey, *Anat. Manip.*; Robin, *Du Microscope, &c.*; Quekett, *on Inject.*; Goadby, in Wythes's '*Microscopist*;' Frey, *Das Mikros.* 1865; Dr. Carpenter, *The Microscope*, 4th edit. 1868; Stricker, *Man. Hist.* i. 1870; Beale, *How to Work &c.*; Rutherford, *Notes &c.* 1872, *Q. Mic. Journ.*; Moseley, *Q. Mic. Journ.* 1871, p. 389, *Inject. Insects.*

INODER'MA, Kütz.—A genus of Palmellaceæ (Confervoid Algæ).

Char. Cells oblong, usually arranged in longitudinal rows, loosely united by a soft jelly; thallus gelatinous, membranous, irregularly expanded.

I. lamellosum. On submersed wood and stones, everywhere.

BIBL. Rabenhorst, *Fl. Alg.* iii. p. 37.

INOME'RIA, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ) with calcareously hardened incrusting fronds, growing on stones in fresh water. The fronds are composed of vertical, parallel, whip-shaped filaments, with the sheaths obscure, connected together, and decomposed into very slender fibrils above. Kützing supposes his *I. Rœmeriana* to be synonymous with Hassall's *Lithonema crustaceum.*

BIBL. Kütz. *Spec. Alg.* p. 343, *Icon. Phys.* ii. pl. 83; Hassall, *Brit. Freshw. Algæ*, p. 266, pl. 65. fig. 3; Rabenhorst, *Fl. Alg.* ii. p. 223.

IN'OSITE.—A crystalline sustance called

muscle-sugar, which is found in the involuntary muscles. It is identical with phaseo-mannite, from the kidney-bean.

Bibl. Frey, *Handb. Hist.* 1870, p. 28; Miller, *Chemistry*, vol. iii.

INSECTS.—A class of invertebrate articulate animals.

Char. Head distinct, furnished with two antennæ; respiratory organs consisting of tracheæ; cutaneous skeleton composed of chitine.

Insects are distinguished from the Arachnida by the head being distinct from the thorax, and the presence of antennæ; and from the Crustacea by the respiratory organs consisting of tracheæ.

Most insects have three pairs of legs; and the body consists usually of thirteen segments—one for the head, three for the thorax, and nine for the abdomen, the legs being attached to the second, third, and fourth segments. But in some (Myriopoda) the segments of the body and the legs are very numerous.

The cutaneous skeleton or integument of insects probably consists of three layers—an outer epidermic, an intermediate pigment, and an internal fibrous layer; but consisting as it does of chitine, it is very imperfectly resolvable into its elementary components. The epidermic layer often presents a distinct cellular aspect (Pl. 28. fig. 30 *a*), sometimes the cells appearing as if flattened and overlapping (Pl. 28. fig. 30 *c*) and their free margins fringed with minute hairs (fig. 30 *b*). In other instances the epidermis appears uniform and structureless. In its deeper portion the epidermis is often strongly coloured by a resinous pigment, which is removable by prolonged maceration in solution of potash or in oil of turpentine. Beneath these imperfectly separable layers, is another representing probably the cutis, and consisting mostly of numerous secondary layers made up of fibres, running parallel or interlacing, and leaving fissures and tubes between them, sometimes presenting a stellate appearance: these fibres may be separated by maceration in caustic potash.

The outer surface of the integument of insects is usually furnished with processes of various kinds, as tubercles, hairs, spines, scales, &c. (see Hairs and Scales). The inner surface also gives off processes, which form a kind of internal skeleton, serving for the attachment of muscles, &c. In sketching the various parts of which the skeleton is composed, it must be understood that they are not always equally distinct, and that upon their degree of development, form, and general structure the characters of the families, genera, and species are mainly founded.

The *head* (fig. 361 *a*) consists of an upper anterior portion (Pl. 26. fig. 1 *d*), the clypeus, and an upper posterior portion (fig. 1 *b*), the epicranium or vertex, which are sometimes separated by a suture; a posterior portion or occiput (fig. 2 +), by which the head is articulated with the prothorax; and a posterior inferior portion (fig. 3 *n*), the gula.

The *eyes* are situated upon the upper, anterior, or lateral parts of the head, and are of two kinds, simple and compound. The simple, called ocelli or stemmata (Pl. 28. fig. 2 *a*; Pl. 26. fig. 24 *b*), are usually from one to three in number, but sometimes are numerous in larvæ; they appear like shining smooth specks (Pl. 26. fig. 4), and usually form a triangle behind or between the compound eyes. They consist of an arched, round, or elliptical cornea, behind which is a conical or cylindrical lens, which is surrounded by a layer of pigment of various colours, resembling a choroid membrane, and is in connexion with a filament of the optic nerve.

The two compound eyes (fig. 361 *b*) are large, usually round or kidney-shaped (Pl. 26. figs. 1 *c*, 3 *c*), situated upon the upper and outer part of the head, and are sometimes so large (as in the Diptera, *Libellula*, &c.) as almost or quite to touch each other in front. They may be regarded as composed of numerous simple eyes closely aggregated; their corneæ vary in thickness, are but slightly arched, quadrangular or hexagonal in form, and in immediate contact laterally. Hence the compound cornea, when viewed from before or behind, presents the appearance of a membrane with numerous beautifully regular six- or four-sided facets (Pl. 26. figs. 5 *a*, *b*). The facets are very variable in number; but often many thousands are present. They are occasionally broader in front than behind, and are sometimes doubly convex (as in the Lepidoptera), at others concavo-convex (in *Libellula*, Pl. 26. fig. 6 *c*), but usually the surfaces are parallel. The cornea possesses a laminated structure.

Behind each cornea is a transparent cone (Pl. 26. fig. 6 *f*), representing a crystalline lens, the apex of which is imbedded in a transparent rod or pyramid laminated in structure, corresponding to a vitreous hu-

mour; and this is probably continuous with a branch of the optic nerve. The length of the lens is variable, in the Diptera being very short, whilst in the Coleoptera and Lepidoptera it is five or six times as long as broad, and in *Libellula* it even exceeds this length. The compound cone, consisting of the lens and vitreous humour, is sur-

Fig. 361.

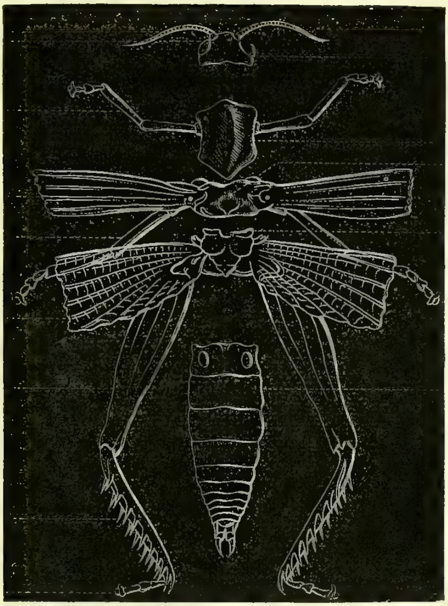


Diagram showing the principal parts of the cutaneous skeleton of a grasshopper.

a the head, with the eyes *b* and the antennæ *c*; *d*, the thorax, consisting of *e* the prothorax, to which the first pair of legs *f* are attached; *g*, the mesothorax, to which the first pair of wings *h*, and the second pair of legs *i* are attached; *k*, the metathorax, to which the second pair of wings *l*, and the third pair of legs *m* are attached; *n*, abdomen; *m*, femur; *o*, tibia with its spines, and *p* tarsus with its claws.

rounded by a sheath of pigment, forming a choroid membrane (Pl. 26. fig. 6*g*), in which numerous tracheæ ramify; this extends over the front of the base of the cone, leaving, however, a small pupillary space or pupil, which is separated from the back of the cornea by an anterior chamber (fig. 6 *d*).

The *antennæ* are noticed under ANTENNÆ.

The *trophi* or organs of the mouth vary in structure in the different orders, but the following form the typical parts: an upper central single piece, the labrum, or upper lip (Pl. 26. figs. 1 *e*, 3 *e*, 22 *a*), forming the upper boundary of the mouth, and articulated at its base with the clypeus. A lower single piece, forming its lower margin, called the labium or lower lip (Pl. 26. fig. 2 *i*, *l*, *m*). This consists of several parts: the most posterior is the mentum (fig. 3 *l*), which is articulated posteriorly with the gula (fig. 3 *n*). Sometimes an intermediate portion occurs, the submentum (fig. 3 *m*); at others this is consolidated with the occiput (fig. 2 *m*). The most anterior portion is the ligula (figs. 2, 3 *i*), which is frequently notched or lobed, and is sometimes furnished with two lateral portions called paraglossæ (fig. 2*). Between the ligula and the mentum or submentum are the palpigers, one on each side (fig. 2 *i*); these are sometimes united, and to them the labial palpi (figs. 2, 3 *k*) are attached. Below the labrum are the mandibles, one on each side, forming two strong curved jaws, and frequently furnished with powerful teeth (figs. 3 *f*, 22 *b*); these are the proper organs of manducation. Below the mandibles are two other lateral organs, the maxillæ (figs. 1, 2, 3 *g*; fig. 22 *c*); they are usually less firm than the mandibles, and serve to hold and convey the food to the back of the

mouth. Each maxilla is furnished with a jointed palp (figs. 1, 2, 3 *h*), and sometimes with an appendage called the galea or helmet (fig. 22 *), and an inner curved and acute portion termed the lacinia or blade (fig. 22 †). In some insects there is a distinct soft and projecting organ, forming the floor of the mouth, the lingua or proper tongue (fig. 22 *d*); the tongue of the cricket (fig. 23) is a favourite and beautiful microscopic object.

These structures are best examined in the Coleoptera or Orthoptera, in which most of the parts we have described are distinct. In the other orders they are altered in structure to adapt them to the nature of their food. Thus in the Lepidoptera, the labrum and mandibles are reduced to three minute triangular plates; the maxillæ are elongated to form the *antlia* (Antlia), at the base of which a pair of minute palpi are often to be detected. The labium is small, triangular, and furnished with a pair of large palpi clothed with long hairs or scales, and serving for the defence of the antlia.

In the Hemiptera (Pl. 26. figs. 26, 27), the labrum is short and pointed, and overlaps the root of the rostrum; the mandibles and maxillæ are transformed into slender lancet-like organs (the maxillary palpi being obsolete), enclosed within the equally elongated horny and jointed rostrum or labium, the labial palpi also being obsolete.

In the Diptera (Pl. 26. figs. 29, 30), the five upper organs, together with the internal tongue, are elongated into lancet-like organs, the maxillary palpi being attached to the base of the maxillæ. These six organs are enclosed in a fleshy thickened piece (the labium), often terminated by two large lobes which act as suckers. In many species, however, some of these lancet-like organs are obsolete. This kind of mouth is termed a *proboscis*.

These varieties are further noticed under the heads of the genera selected for illustration.

Behind the head is the *thorax*. This consists of three rings or pieces, each of which supports a pair of legs (fig. 361 *e*, *g*, *k*). The first ring is called the prothorax (*e*), the second the mesothorax (*g*), and the third the metathorax (*k*). Each of these rings consists of a dorsal and a sternal piece; the dorsal half-rings are called the pronotum, mesonotum, and metanotum; the ventral or sternal the prosternum, mesosternum, and metasternum. In the four-winged insects, the anterior wings are attached to the central piece or mesothorax (*g*), the posterior wings to the metathorax (*k*). In the Diptera, the wings are attached to the mesothorax, and the halteres to the metathorax. Various other subdivisions have been made of these parts, but they are too numerous to mention here. It may be remarked, however, that the epimera are the pieces to which the basal joints of the legs are directly attached; that the under part of the thorax or pectus is sometimes furnished with an elongated acuminate appendage, the sternum; and that the scutellum or shield is a piece existing at the upper and back part of the mesonotum, and extending between the wings.

The *legs* (usually called feet) are placed on the underside of the body, and are joined to its segments at an articular cavity existing between the sternum and the epimeron, called the acetabulum. Each leg usually consists of five parts. The first is the hip or coxa (Pl. 28. fig. 9 *g*); but sometimes there is a small very movable piece between the epimeron and the coxa (Pl. 28. fig. 9, between *f* and *g*), called the trochantin; this, however, is generally absent or consolidated with the coxa. The second joint is the trochanter (Pl. 28. fig. 9 *h*); it is mostly small, and annular. The third is the thigh or femur (fig. 361 *m*; Pl. 27. figs. 4, 5, 7 *d*), the thickest and usually the largest joint of the leg. Next comes the fourth, the tibia (fig. 361 *o*; Pl. 27. figs. 4, 5, 6, 7 *c*), which is thinner, usually compressed, and frequently furnished with spines, spurs, or other appendages, especially at its end; in the ant the tibiæ have each a beautiful pectinate process. The last portion is the foot or tarsus (fig. 361 *p*; Pl. 27. figs. 6, 7 *a*), which consists of several joints arranged in a row. The number of these joints varies in different insects; sometimes it is different in the anterior and posterior pairs of legs; they are, however, most commonly five. The last joint of the tarsus is usually furnished with appendages, in the form of hooks or claws, mostly two, and frequently serrated, especially near the base. Sometimes also it has two or three delicate membranous or fleshy cushions, called pulvilli (Pl. 27. figs. 7 & 8); these are more or less covered with hairs, which are sometimes terminated by little disks (fig. 9), and by which it is supposed that the insects are enabled to ascend or adhere to polished surfaces in opposition to gravity. In other

insects elegant brush-like appendages are met with in the same situation. Disks of the same kind but larger, and peculiarly-arranged hairs, sometimes occur upon the upper joints of the tarsus (Pl. 27. fig. 6, DYTISCUS; and fig. 4 *a*, APIS).

The structure of the legs of insects in the larval state (Pl. 27. figs. 32, 33) differs considerably from that of the imago as described above.

The *wings* are dry, membranous, and transparent organs, consisting of two layers, which are confluent at the margins, and are folds of the integument. Between them run canals, commonly called veins, nerves or nervures, which are more or less numerous and ramified; and upon their arrangement the distinguishing characters of the genera &c. are sometimes founded (WINGS). The veins are formed by two wide horny half-canals in the upper and under plates, of which the wings consist. The main veins arise from the point of attachment of the wings to the thorax, and gradually diminish in diameter until they reach the extremity of the wings. The veins convey the circulating liquid, and contain each a tracheal branch, which communicates with the tracheæ of the thorax. Each nervure contains a trachea; and the blood circulates around it. In flight they are said to be distended and the wings kept expanded, by air from the interior of the body. In some kinds of wings the circulating currents are not confined to narrow channels as in the veins, but traverse a large part of the breadth of the wings (COCCINELLA).

Most insects have four wings; but in some the males only are furnished with these appendages. In the Diptera, the posterior pair of wings are rudimentary, being replaced by two little club-shaped bodies, called the *halteres*, poisers, or balancers. In this order also, and in some insects belonging to other orders, a pair of small and rounded membranous or scaly appendages are attached to the back of the base of the first pair of wings, called in the former the squamæ halterum, and in others, alulæ or winglets. The anterior pair of wings are in some insects, as in the beetles (Coleoptera), hard, horny, and opaque, forming wing-covers or ELYTRA (fig. 367), from the presence of a horny layer. And the lower wings, which are usually larger, are folded together beneath them, when at rest. In others, the posterior wings disappear, and the elytra coalesce at their inner margins. Sometimes the anterior wings are horny or leathery at the base, and membranous towards the summit (fig. 366); these are called hemelytra. At others, all the wings are thin, membranous, and transparent, as in the *Hymenoptera* and *Neuroptera*.

In the Lepidoptera, they are covered with beautiful feathers or SCALES.

There are also other modifications of the wings of certain insects, adapting them for special functions. In the Orthoptera these modifications are the agents producing the well-known chirping sounds, as in the male cricket and grasshopper. In the common house-cricket, *Acheta domestica*, each of the upper wings or elytra exhibits a clear space near the centre (Pl. 27. fig. 10 *a*), traversed by a single vein only, or at least by a very few veins. This space has received the name of the drum or tympanum. Bounding it externally is a large dark longitudinal vein, provided with three or four elevated longitudinal ridges. Immediately in front of the tympanum, near the base of the elytra, is a transverse horny ridge, tapering outwards and furnished with numerous short transverse ridges or teeth, and forming a kind of file or bow (Pl. 27. fig. 10 *b*). When the two elytra are rubbed across each other, the bow being drawn across the ridges gives rise to the peculiar sound, the intensity of which is increased by the tympanum acting as a sounding-board. The apparatus of the grasshopper is essentially of the same structure. It must be stated, however, that various other explanations of the origin of the stridulating noise produced by these insects have been given. Thus by some authors the two bows are stated to work across each other, whilst by others the legs are supposed to act against the bow. This subject possesses interest for future observation.

In other insects, there is a peculiar mechanism for uniting the anterior and posterior wings of each side, so that they may be kept steady and may act in unison during flight. In the Lepidoptera, the moths only are provided with a minute hook arising from the base of the costal nerve of the lower wing, and inserted into a socket near the base of the main nerve, on the under side of the upper wing. In the Hymenoptera, there are many such hooks arranged along part of the costal nerve at the anterior and upper margin of the second pair of wings (Pl. 27. fig. 13). When the wings are expanded, these attach themselves to a little fold on the posterior margin of the anterior wing

(fig. 11 *n*), along which they play freely when the wings are in motion, sliding to and fro like the rings on the rod of a window-curtain. These hooks are somewhat twisted towards their free end, recurved and sometimes notched at the point. They vary in number in different genera and even in the sexes. In the Hemiptera the whole margin of part of the anterior wing is hooked over a corresponding recurved part of the posterior, so as to produce the same effect.

The halteres of the Diptera and the elytra of beetles present in certain parts a multitude of vesicular projections of the external membrane; and a nervous filament passes to each. Braxton Hicks considers them to be organs of smelling.

The *abdomen* (fig. 361 *n*) forms the third and terminal portion of the body of insects. It usually consists of nine or ten rings or joints, the posterior of which, however, are sometimes so concealed, so small or so fused with the others, that they appear to be absent. The abdomen contains the principal part of the alimentary canal and its appendages, with the organs of reproduction.

The *alimentary canal* varies in length in different insects, and even in the same insect at various periods of its development. It consists of the following parts:—1. The œsophagus (Pl. 28. fig. 2 *b*), a muscular organ extending through the thorax; it is sometimes dilated to form a crop or ingluvies, as in the Lepidoptera, Hymenoptera, and Diptera; and this occasionally forms a lateral sac, connected with the œsophagus by a narrower portion only, and called a sucking stomach. 2. Next follows the muscular stomach, proventriculus or gizzard (Pl. 28 *c*), which is distinguished by the frequently great development of its lining membrane into plates, teeth, or hooks of horny tissue (Pl. 27. fig. 1); these serve to triturate the food, and have long been known as beautiful microscopic objects. 3. This is succeeded by a long cylindrical true stomach or ventriculus (*d*), in which digestion takes place. 4. Behind this is a longer or shorter small intestine (Pl. 28. fig. 2, between *d* and *f*), terminating in 5, a dilated portion, forming a large intestine or colon; behind which is a short rectum. The structure and length of the parts of the alimentary canal vary generally according to the nature of the food, although this is not always the case in regard to the latter.

The alimentary canal is covered by an outer homogeneous peritoneal layer; beneath which is a muscular coat, consisting of longitudinal and transverse fibres. Internally it is lined by a homogeneous epithelial layer, consisting, in part at least, of chitine. Between the latter and the muscular coat, at the middle of the alimentary canal, is a layer of cells, which probably perform a glandular function. The large intestine or colon of most insects in the imago state contains from four to six peculiar organs of doubtful nature, arranged in pairs, either transversely or longitudinally. These consist of transparent rounded, oval, or elongated tubercles, projecting inside the colon, sometimes with a horny ring at the base, and traversed by tufts of tracheæ. These organs are most numerous in the Lepidoptera. They are never found in insects in the larva- or pupa-state.

In most insects salivary glands are present as one, two, or rarely three pairs of colourless sacs or tubes of very variable form and length, sometimes scarcely extending beyond the prothorax, at others accompanying the alimentary canal into the abdomen. They consist of an outer homogeneous envelope, lined with colourless nucleated cells, and frequently have one or more distinct ducts, sometimes containing a spiral fibre; they terminate near the mouth, in some insects the ducts previously expanding into a reservoir.

A distinct liver is not present in insects, its function being performed by the glandular cells in the walls of the true stomach. In many insects, cæcal appendages arise from the latter, and also contain cells which secrete a biliary liquid.

In some insects the small intestine is furnished with glandular appendages in the form of tubular cæca, probably representing a pancreas.

Intimately connected with the digestive and assimilative process is a curious organ called the fatty body. This attains its maximum of development towards the end of the larval period of existence. It consists of a number of fat-cells imbedded in a reticular or lamellar tissue (Pl. 28. fig. 28), composed of a number of somewhat angular lobes connected by narrow processes having interspaces between them. These are originally formed from rounded nucleated cells, which have given off anastomosing processes (fig. 29). It is traversed by a number of slender tracheæ, and occupies the interspaces of the various abdominal organs. Each lobe consists of an outer structureless membrane,

enclosing the fatty matter imbedded in an amorphous or granular substance. It appears to form a reservoir of nourishment for the insect during the pupa-state.

In most insects are found several slender and elongated, mostly simple, tubular glands, opening by simple or united ducts into that end of the true stomach corresponding to the pylorus (Pl. 28. fig. 2 *e*). Their free ends are either cæcal or unite with each other. They are often very long, and much convoluted around the intestines, sometimes presenting a varicose appearance, and dilated near their termination. These are the Malpighian vessels, and they probably perform the function of a kidney, uric acid having been found in them. They are usually yellowish or brownish, and consist of a homogeneous outer coat lined with epithelial cells. Some authors, however, consider that the renal organ is represented by one or more long vessels convoluted upon the colons and opening close to the anus. And we have found in the caterpillar of the fox-moth, *Lasiocampa rubi*, numerous long convoluted tubes, of a milk-white colour, filled with perfect octahedra and prisms of oxalate of lime. These tubular organs terminated in the rectum close to the anus by very slender ducts, whilst at the upper ends, which reached to about the anterior third of the body, they were coiled upon themselves, or united with each other.

Other glandular or secreting organs also occur in insects. Thus organs corresponding to the cutaneous glands of the Vertebrata are often met with as rounded glandular cysts diffused beneath the integument, and called glandulæ odoriferæ; they open at the junction of the segments of the body, or at the joints of the legs, by very short ducts, and pour out a strongly-smelling secretion. In other insects, similar organs are concealed at the posterior end of the body, and pour out their secretion near the anus. Among the Hymenoptera, the females are often furnished with a glandular apparatus which secretes the poison of the STING.

Spinning organs. A large number of those insects which undergo perfect metamorphosis are furnished in the larval state with spinning organs, with the secretion of which many larvæ, before entering the pupa state, weave a cocoon or enclose a cavity in which to pass their period of rest, while others use this secretion for agglutinating foreign bodies to serve the same purpose. The glands secreting the silk consist of two long, tubular cæca (Pl. 27. fig. 16), which in a more or less coiled state occupy the sides of the body, and terminate anteriorly in two narrow excretory ducts, dilated to form a reservoir, and the common orifice of which opens outside the mouth on a short tubercle beneath the labium. The caterpillar is able to compress the silken threads by the contraction of an angle formed by the two capillary tubes at their point of union, and is thus enabled to suspend itself by the threads. The material of the silk is always colourless, and derives the colour which it presents in certain instances from a varnish secreted in the reservoirs, and issuing along with the former.

The *heart* in insects exists as a long contractile dorsal vessel, constricted at intervals. This terminates posteriorly in a blind end, and is narrower in front. The posterior portion performs the functions of a heart, whilst the anterior represents an aorta, and conveys the blood from the heart to the body. From the mouth of the aorta the blood passes without any vascular walls, in regular currents taking all directions, and running into the antennæ, the extremities, the wings, and other appendages, returning as a venous current. The blood finally forms two principal lateral currents directed towards the end of the abdomen; and, accumulating in the neighbourhood of the heart, is brought by its diastole through the lateral valvular tissues existing in it, whence it is again driven through the aorta as before. The walls of the dorsal vessel consist of longitudinal and transverse fibres, surrounded externally by a very delicate peritoneal layer. The cavity of the heart is lined by another delicate membrane, which in the constricted parts forms internal valvular projections, whereby the dorsal vessel is divided into as many chambers as there are constrictions. Each of these cardiac chambers is furnished at its front end, right and left, with a fissure which can be closed internally by a valvular membranous fold. The cardiac chambers contract in regular succession from behind forwards, and thus, with the aid of the valvular apparatus, which prevents the lateral exit of the blood, propel this liquid into the aorta. This is nothing more than a continuation of the most anterior heart-chamber, and runs as a simple narrow tube beneath the back of the thorax, where it terminates either in a single aperture, or divides into several short branches,

which also terminate suddenly in open orifices. The number of chambers varies; but very frequently there are eight.

In the antennæ, legs, and other appendages of the body of insects, the arterial and venous currents may be seen running together, whilst in the wings the currents are distinct.

Minute capillaries have been detected very generally diffused.

The blood of insects usually consists of a colourless liquid containing rounded or oval, colourless, nucleated corpuscles (Pl. 40. fig. 33); but sometimes it is yellowish or greenish, and rarely red.

The *respiration* of insects is effected by means of TRACHEÆ, two or more large trunks of which usually traverse the body longitudinally, giving off branches which run in all directions, and communicating with the air by numerous short tubes, connected at or near the sides of the body with orifices termed SPIRACLES or stigmata. Of those insects which live in water, some have stigmatic orifices which are brought into relation with the air at the surface of the water; whilst others in the larval state respire the air mixed with the water in which they live, this process being facilitated by the presence of external branchiæ, or processes of the integument in the form of leaves, plates, or hairs, through which numerous tracheæ ramify in every direction.

The *nervous system* of insects consists essentially of a series of ganglia arranged in pairs, one for each segment of the body, and situated between the alimentary canal and the under surface of the body. The ganglia of each pair are mostly united with each other, but sometimes distinct, and are connected with those adjacent by longitudinal cords. The uppermost pair of ventral ganglia are connected by two lateral cords surrounding the œsophagus with a large cephalic ganglion or brain. From the ganglia branches are distributed to all parts of the body. A sympathetic system of nerves is also present.

Want of space compels us to limit the notice of the reproductive organs to the description of Pl. 27. figs. 18 & 19.

Many insects undergo complete metamorphoses, between the period at which they are hatched and that at which they attain their full development. On first leaving the egg, they assume a more or less worm-like form, known as the larva, caterpillar, or maggot. The next stage is that in which they usually neither move nor take food, when they form the nympha, pupa, or chrysalis. This state is succeeded by that of the perfect insect or imago. In other insects, however, among the Orthoptera, Hemiptera, and Neuroptera, the metamorphosis is incomplete, the body, legs, and antennæ of the larva being nearly similar in form to those of the imago, but the wings are wanting. In some insects, also, of the above orders, the pupa continues to be active, differing only from the larva in its larger size, and in having acquired rudimentary wings (Pl. 28. figs. 15, 17, 21).

In some insects the only change consists in ecdysis, without material alteration in structure. Parthenogenesis occurs; and some larvæ reproduce.

Examination, &c. The external parts and organs of insects are usually examined as opaque objects, the animals being held in the stage-forceps. This method, however, is often very unsatisfactory; and the best is to press them as much as possible between two slides, without crushing, and to fasten the slides together with india-rubber bands or fine string, so that the parts may dry in the compressed form. When subsequently soaked in oil of turpentine, and mounted in balsam, they will become much more transparent and distinct. By prolonged maceration in turpentine, the whole of the pigment may be removed, which causes the structure to be seen very distinctly. When the organs are very hard and thick, they may be softened by boiling water, or solution of potash, before being pressed between the slides.

The internal organs, which are very delicate, must be brought to view by dissection under water, the insect being fixed by pins stuck into the leaded cork (INTROD. p. xxiv).

The smaller and more delicate insects, aquatic larvæ, &c. are best preserved in solution of chloride of calcium or glycerine, mounted in suitable glass cells.

To preserve insects for the future examination of the internal structure, they should be kept in solution of chloride of zinc; but when very soft and fragile, they may be kept in spirit and water.

Insects are divided into two sections, and these into twelve orders, thus:—

Section 1. *Apiropoda.*

Char. Legs numerous; thorax not separated from the abdomen.

Ord. 1. *Myriopoda.* Wings absent; legs numerous (24 or more), terminated by

a single claw; eyes collected into two groups, variable in number, sometimes absent (fig. 362).

Section 2. *Hexapoda.* Legs six; thorax distinct from the abdomen.

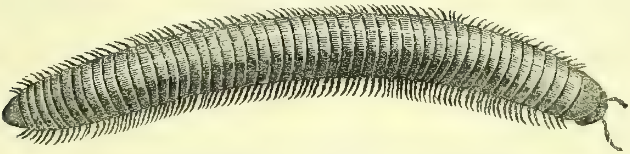
Ord. 2. *Thysanura.* Wings absent; not undergoing metamorphosis; not parasitic; mouth furnished with mandibles and maxillæ; eyes simple, in two groups; abdomen mostly terminated by setæ or a bifid tail.

Ord. 3. *Anoplura* or *Parasitica* (Lice, Pl. 28. figs. 3–8). Wings absent; not undergoing metamorphosis; parasitic (eyes two, simple, sometimes none).

Ord. 4. *Suctoria* or *Siphonaptera* (Fleas). Wingless; metamorphosis complete; mouth suctorial; rostrum composed of two serrated laminæ and a thin suctorial seta, included in a jointed two-valved sheath.

Ord. 5. *Strepsiptera* or *Rhipiptera.* Males with four wings; anterior wings two small

Fig. 362.



Iulus terrestris. Magnified 4 diameters.

movable corpuscles; posterior wings large, membranous, in the form of a quadrant of a circle, longitudinally folded like a fan. Females, apterous, vermiform, without legs. Metamorphosis complicated; mandibles two, narrow, somewhat curved; palpi two, biarticulate, far apart, inserted beneath the head (larvæ, pupæ, and females living parasitically in Hymenopterous insects).

Ord. 6. *Diptera* (Flies). Wings two, with alulets at the base; two halteres; mouth suctorial; labium not furnished with palpi, prolonged into a proboscis or sheath, and enclosing setæ variable in number; palpi (maxillary) two, at the base of the proboscis; metamorphosis complete.

Ord. 7. *Hymenoptera* (Bees, Wasps, &c.).

Fig. 363.

Tenthredo nassata.
Magnified 2 diameters.

Wings four, membranous, posterior ones smaller, and with fewer veins; maxillæ elongate, generally slender, sheathing the labium; abdomen of the females almost always terminated by an ovipositor or a sting; metamorphosis complete (fig. 363).

Ord. 8. *Lepidoptera* (Butterflies, Moths). Wings four, membranous, covered with coloured scales; mouth furnished with an involute, spiral tongue, composed of the elongated maxillæ; metamorphosis complete (fig. 364).

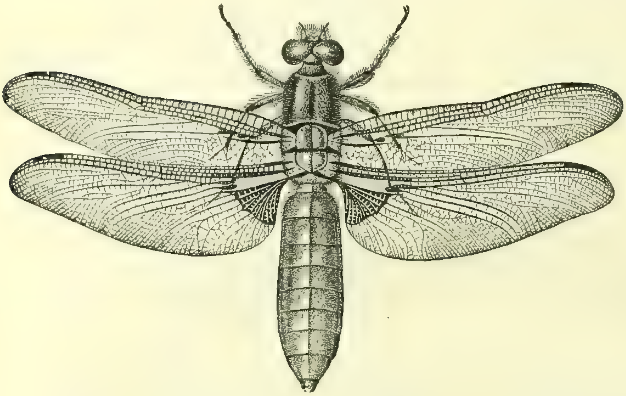
Fig. 364.

Danaïs Plexippe.
Nat. size.

Ord. 9. *Neuroptera* (Lace-wings, Dragonflies, &c.). Wings four, membranous, generally pellucid, reticulated, naked, very often equal; mouth not suctorial, but mostly made for manducation; mandibles in some obsolete; females never furnished

with a sting, and but rarely with a borer or exserted oviduct; metamorphosis mostly incomplete, in some complete (fig. 365).

Fig. 365.



Libellula depressa.
Nat. size.

Ord. 10. *Hemiptera* (Bugs, &c.). Wings four, all membranous, or the anterior ones coriaceous at the base, and thicker; mouth with a jointed rostrum (labium), en-

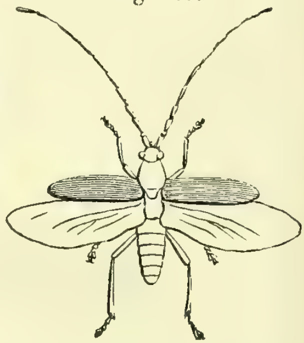
Fig. 366.

Reduvius tuberculatus.
Nat. size.

sheathing setæ (mandibles and maxillæ); palpi none; metamorphosis with few exceptions incomplete (fig. 366).

Ord. 11. *Orthoptera* (Grasshoppers, Crickets, &c.). Wings four, the upper coriaceous, veiny, the inferior membranous, longitudinally plaited like a fan; mouth serving

Fig. 367.



Cerambyx ædilis.
Nat. size.

for manducation, with strong mandibles; maxillæ furnished with a cylindrical helmet; metamorphosis incomplete.

Ord. 12. *Coleoptera* (Beetles). Wings four, anterior hard, coriaceous or horny (elytra), covering the posterior, which are membranous and transversely folded; mouth formed for manducation, furnished with mandibles, maxillæ, and palpi, both labial and maxillary; metamorphosis complete (fig. 367).

Bibl. Newport, *Todd's Cycl. Anat. and Phys.* art. *Insects*; Kirby and Spence, *Intr. to Entom.*; Burmeister, *Handb. d. Entom.* (tr. by Shuckard); Newman, *Hist. of Insects*; Siebold, *Lehrb. d. vergl. Anat.*; Straus-Durckheim, *Consid. général. s. l'Anat. Comp. d. Anim. Articul.*; Westwood, *Intr. to the Class. of Insects*; id. *Butterflies of Great Britain*; V. d. Hoeven, *Handb. d. Zool.*; Stephens, *Man. of Brit. Beetles, and Brit. Entom.*; Laporte and Gory, *Hist. nat. d. Insect.*; Spry and Shuckard, *Brit. Coleopt.*; Kirby, *Monogr. Apum Angl.*; Curtis, *Brit. Entom.*; Panzer, *Deutsch. Insekt.*; Walker, *Insecta Brit.*; Dallas, *El. of Entom.*; *Ann. des Sc. Nat.*, the *Ann. Nat. Hist.*, and the *Linn. Trans.* passim; Fabre, *Ann. des Sc. Nat.* sér. 4. vii.; Ganin, *für wiss. Zool.* 1869; Kowalevsky, *Mém. de l'Acad. St.-Pétersb.* t. xvi. 1871; Douglas and Scott, *Hemip. Heter. Ray Soc.*; Schultze, *Q. Mic. Journ.* 1868; Landois, *Schultze's Archiv*, 1867; Lyonet, *Ann. des Sc. Nat.* sér. 2. t. v.; Lacaze-Duthiers, *Ann. des Sc. Nat.* sér. 3.

t. xix.; Huxley, *Linn. Trans.* 1858, p. 290; Gerstaecker, *Klass. und Ordnung*; Weismann, *Entwick. der Dipter.*; Herold, *Ent. der Schmetter.*; Metschnikow, *Zeit. für wiss. Zool.* B. xvi.; Siebold, in *Müller's Archiv*, 1837; Leydig, *Lehrb. der Hist.*; Gegenbauer, *Vergl. Anat.* 1870; Lubbock, *Linn. Trans.*, *Nature Series*, *Phil. Trans.*; Scudder, *Entom. papers in Smith. Inst. Trans. &c.*; Braxton Hicks, *Journ. Linn. Soc.* i. p. 136; id. *Linn. Trans.* xxii. p. 141, xxiii. p. 189; T. West, *Linn. Trans.* xxii. p. 393; Hepworth, *Q. Mic. Journ.* ii. p. 158; Packard, *Mem. Acad. (Peabody) Entomol.*

INSILEL'LA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, fusiform, with a turgid ring (hoop?) interposed between the valves, which are equal. (Represents a terete *Biddulphia.*) Marine.

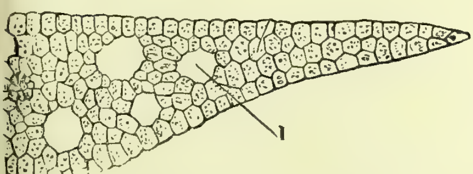
I. africana. Frustules with four constrictions, broader and subglobose in the middle, diminishing in size towards the acuminate ends; no markings visible (by ordinary illumination); length 1-530.

Found on the coast of Africa.

Bibl. Ehr. *Ber. d. Berl. Akad.* 1845, p. 357; Kütz. *Sp. Alg.* p. 32.

INTERCELLULAR Passages, Spaces, &c. of Plants.—Where the cells of vegetable tissue are of any but six- or twelve-sided forms, interspaces must exist between them. These are especially evident in pa-

Fig. 368.



Vertical section of half a leaf of a Potamogeton, with air-spaces *l*.

Magnified 200 diameters.

renchyma formed of rounded cells, where there exist of course, angular, intercommunicating, intercellular *passages.* The stomata of Leaves always communicate with such intercellular passages, larger in the lower part of the parenchyma of leaves. Intercellular spaces are lacunæ of larger size, definite or indefinite in form, bounded by a number of cells of less capacity than the space itself. These are especially large and abundant, as air-receptacles, in aquatic plants, both in the stems and leaves, as in the Nymphæaceæ, Naiadaceæ (fig. 368), and Hydrocharidaceæ, &c., but also common in most Monocotyledonous plants, such as Juncaceæ (Pl. 38. fig. 18), Araceæ, Grasses, &c.

Intercellular spaces and canals likewise serve as Receptacles for Secretions, as in the case of the glands of the Aurantiaceæ (fig. 280) (see also Glands), and the turpentine-canals of the Coniferæ. The milk-vessels of plants appear to be formed sometimes in intercellular canals, sometimes out of cells (Laticiferous Tissue).

Bibl. General works on Structural Botany.

INTERCELLULAR SUBSTANCE of Plants, or Secondary Cell-deposits.—When we make fine sections of many kinds of cellular structure, as for instance of the horny albumen of the seeds of Palms (*Areca*, Pl. 38. fig. 21) or other plants, of the collenchymatous tissue beneath the epidermis of the Chenopodiaceæ, &c., of the substance of cartilaginous Algæ, of many woods, &c., we find an appearance of intervals between the lines bounding the component cells, which intervals are filled up with apparently homogeneous substance. Thus seen and no further investigated, the interposed matter was formerly described as *intercellular substance*, a peculiar form of vegetable organization; and some went so far as to imagine that cells originated free in this, and subsequently became glued together and fixed by the solidification of the whole (Unger and Endlicher). The application of dilute sulphuric acid to preparations of this kind, with iodine, generally shows clearly that the supposed intercellular substance consists of secondary deposits really inside the cells (Pl. 38. fig. 22). Recent observations go to prove that the supposed intercellular substance, a matter secreted or otherwise produced between the cells of a tissue, is of very rare occurrence, even if existing at all. Probably the appearance is produced by modification of the cell-wall. See Epidermis and Secondary deposits, Wood and Albumen,

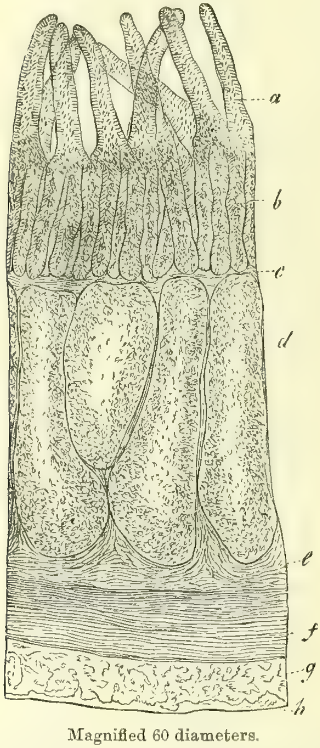
Bibl. Mohl, the papers cited under Cell-membrane; Unger, *Grundzüge der Anat. u. Phys. der Pfl.* Vienna, 1846. p. 18; Mulder and Harting, *Phys. Chem.* (Edinb. 1849), pp. 399, 469; Hartig, *Ann. des Sc. Nat.* 2 sér. v.; Wigand, *Intercell. subst., &c.*, Brunswick.

1850; Cohn, *de Cuticula*, *Linnæa*, xxiii. p. 337, 1850; Schacht, *Pflanzenzelle*, Berlin, 1852, p. 76; Bentley, *Man. Bot.*; Henfrey (Masters), *Elem. Course.*

INTESTINES.—The intestines consist of three coats, an outer, peritoneal (PERITONEUM), an inner or mucous membrane, and an intermediate muscular coat.

The areolor tissue of the mucous membrane is often indistinctly fibrous, especially its inner portions, where it forms the basement membrane; it contains scattered, roundish, elongate nuclei, without elastic tissue. Between the proper mucous membrane and the submucous tissue, is situated

Fig. 369.



Magnified 60 diameters.

Perpendicular section of the wall of the lower part of the ileum of the calf: *a*, villi; *b*, Lieberkühn's glands; *c*, muscular layer of the mucous membrane; *d*, follicle of a Peyer's gland; *e*, subjacent portions of the submucous tissue; *f*, circular muscular fibres; *g*, longitudinal ditto.

a layer of longitudinal and transverse unstriped muscular fibres, frequently, however, indistinct in man.

The epithelium of the intestines consists of a single layer of cylindrical cells, containing a transparent oval nucleus, with one or two nuclei, and granular matter.

The free border of uninjured epithelium-cells presents a broad seam or hem, which exhibits a fine striation running parallel to the long axis of the cell. Besides the ordinary cylindrical or columnar cells, and constituting a very remarkable appearance, are certain cup-, bell-, or goblet-shaped structures, the open mouths of which are directed towards the cavity of the intestine, and which contain at their base a mass of protoplasm of variable size with or without a nucleus. It is a question whether or not these goblet-cells are modified epithelium-cells, or represent peculiar morphological elements. Occasionally portions of these cells are cast off, and give rise to cup-like bodies.

The surface of the small intestines is covered with VILLI, which are absent in the large intestines, and in every villus one or two spaces are found, constituting the origin of the lacteals.

The elements of the muscular coat are organic or unstriped muscular fibres, consisting of pale, homogeneous, fusiform, flattened cells, with an elongated nucleus. The fibres frequently present knotty expansions, and sometimes zigzag flexuosities.

The glandular organs of the small intestines consist of:—Brunner's or the racemose glands; Lieberkühn's follicles or the tubular glands; Peyer's, the aggregate or agminate glands; and the solitary glands or follicles.

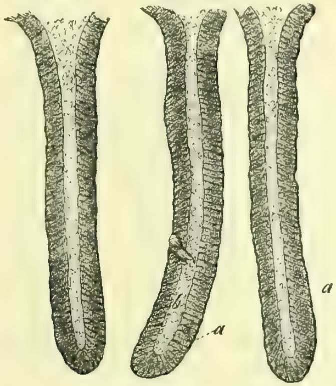
Brunner's glands are situated in the submucous tissue of the duodenum, extending about as far as the orifice of the choledic duct. If a portion of the intestine be kept stretched, or distended with air, and the muscular coat be dissected off, they are seen as yellowish, flattened, roundish-angular bodies, mostly about 1-50 to 1-25″ in size, the short ducts of which pass through the mucous membrane. They secrete an alkaline mucous liquid.

Lieberkühn's follicles, or the tubular glands (fig. 370), are distributed throughout the small intestines, extending through the substance of the mucous membrane. They are very numerous, straight, narrow, slightly dilated at the ends, and rarely bifurcate. They vary in length from 1-60 to 1-84″, and consist of a delicate basement membrane, lined with epithelium.

Peyer's glands are rounded or elongated

flattened aggregations of glands, appearing upon the inner side of the intestine as slightly depressed spots. They are most numerous in the ileum, but are sometimes

Fig. 370.

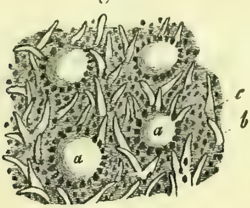


Magnified 60 diameters.

Lieberkühn's follicles, from the pig: *a*, basement membrane and epithelium; *b*, cavity.

found in the lower part of the jejunum, or even its upper part and the duodenum. They are usually twenty, thirty, or more in number. They vary in length from 1-25 to $1\frac{1}{2}''$. Each consists of an aggregation of closed and rounded follicles, from 1-70 to

Fig. 371.



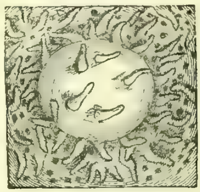
Magnified 10 diameters.

Portion of a Peyer's gland, human: *a*, follicles surrounded by the orifices of Lieberkühn's glands; *b*, villi; *c*, scattered Lieberkühn's glands.

1-12″ in diameter, partly seated in the mucous membrane itself, partly in the submucous tissue. The follicles are surrounded by a ring of Lieberkühn's glands, which, with villi, also occupy the intervening portion of the mucous membrane. Each follicle consists of a tolerably firm coat of indistinctly fibrous areolar tissue, with scattered nuclei, enclosing a grey soft substance consisting of innumerable nuclei and cells, from 1-3000 to 1-1500″ in diameter, with a few granules of fat. The follicles are surrounded by a vascular network, which sends off branches to their interior.

The solitary glands agree in structure with the individual follicles of Peyer's glands. Their free surface is usually convex, and covered with villi (fig. 372).

Fig. 372.

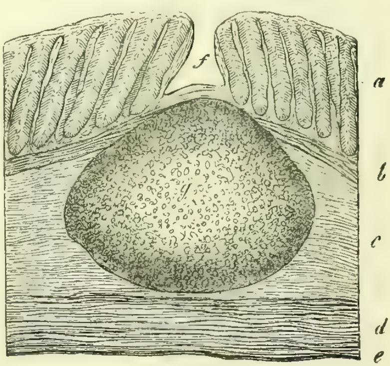


Solitary gland, covered with villi, from the jejunum.

The glandular organs of the large intestines are Lieberkühn's glands and the solitary follicles.

The Lieberkühn's glands agree in structure with those of the small intestines, except that they are larger and broader in proportion to the greater thickness of the mucous membrane. The solitary follicles also differ from those of the small intestine

Fig. 373.



Magnified 45 diameters.

Solitary follicle from the colon of a child: *a*, tubular glands; *b*, muscular coat of the mucous membrane; *c*, submucous tissue; *d*, transverse muscular fibres; *e*, peritoneum; *f*, depression in mucous membrane over the follicle *g*.

in their larger size, and in the circumstance that each of the minute elevations of the

mucous membrane produced by them exhibits a rounded or elongated opening, leading to a depression in the mucous membrane over the follicle (fig. 373). This, however, has no communication with the follicle.

The investigation of the structure of the intestines is a matter of some difficulty. The epithelium must be examined in a perfectly fresh state. The glands are most readily seen in portions hardened by absolute alcohol or chromic acid; whilst some have recommended boiling with acetic acid (80 per cent.), then drying and making sections with a Valentin's knife. The muscular elements are rendered most distinct by maceration with dilute nitric acid (20 per cent.).

The capillaries of the intestines are very beautiful when injected; but great care is required in securing the vascular branches to prevent the escape of the injection.

Two thick layers of ganglionic nervous masses are distinguishable in the intestines. One is situated in the tunica submucosa, and the other between the circular and longitudinal muscular fibres. The former is a flat layer with a few ganglia projecting towards the mucous membrane and penetrating among the follicles; and the latter is more irregular, presenting nodulated ganglionic masses. The ganglia give off and are traversed by nerves that form a plexus, some of the nerves of which join the ganglionic layers, and others unite with the mesenteric nerves. The nerves are non-medullated.

Bibl. Kölliker, *Mikrosk. Anat.* ii. and the Bibl. therein given; Verson and E. Klein, in *Stricker's Man. Hist.*; Eimer, *Gesch. der Becherz.* in *Stricker's Man. Human & Comp. Hist. Syd. Soc.*

IN'ULIN.—A variety of starch. It is turned yellow by iodine.

IODINE.—Solution of iodine is often useful for dyeing and rendering very transparent objects more distinct, and for its producing with some vegetable and animal tissue and substances colours by which they may be distinguished. The general results of its action are enumerated in the Introduction, p. xl; and special remarks are made under the heads of the tissues.

An aqueous solution of iodine is the best for general use; but a solution in spirit is much stronger. A very strong solution may be made by dissolving iodine in a solution of iodide of potassium. Solutions of iodine in chloride of zinc, and of iodide of zinc are valuable reagents for cellulose. See Schultze's Test.

Iodized serum is made of pure amniotic fluid and a small quantity of iodine. It has a pale, feeble, yellow tint. It is very useful in preparing animal structures for the microscope.

IRIDÆA, Bory.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one common British species, *I. edulis*, a dull-red, obovate, leaf-shaped sea-weed of fleshy-cartilaginous texture, 4-18″ long, the central substance composed of longitudinal, the cortical of closely-packed moniliform perpendicular filaments. Fructification: *spores* in spherical masses (*favellidia*), imbedded in the frond in wide patches near the extremity; *tetraspores* in dense band-like immersed sori.

Bibl. Harvey, *Brit. Mar. Alg.* 150, pl. 19 A; *Phyc. Brit.* pl. 97; Greville, *Alg. Brit.* pl. 17; *Eng. Bot.* pl. 1307.

IRIDESCENCE. See Introduction, p. xxx.

IRIS. See Eye, p. 299.

ISARIA, Hill.—A genus of Isariacei (reputed Hyphomycetous Fungi), growing upon dead insects, fungi, or twigs or leaves of plants. *I. farinosa*, Fries, grows to a height of 1-2″ on dead pupæ, spiders' nests, &c. *I. arachnophila*, Ditton, *intricata*, Fr., *puberula*, Berk., and *Friesii*, Montagne, are also British. *I. citrina* (figs. 374, 375) is a small species, growing gregariously on vegetable substances.

Fig. 374.

Isaria citrina. Plants on a fungus. Natural size.

Tulasne has recently published an interesting paper on *Isaria*, showing that at any rate some of the forms referred to this genus are conidiiferous fruits of certain *Sphæriæ*; in particular that *Is. crassa* (*farinosa*, Fr.) is a form of *Sphæria militaris*. This plant is found most frequently on the larvæ of *Bombyx Rubi*; and the first sign of its growth is the formation of a mildew, between the rings of the abdomen, very much resembling a *Botrytis*. Subsequently the body of the

larva, quite filled up and rigid with mycelial growth, bears the claviform receptacles of *Isaria*; and at a still later period, some of the larvæ bear the claviform receptacles and

Fig. 375.

Isaria citrina. A single plant, showing the fruit. Magn. 20 diams.

the conceptacles, containing asci, of *Sphæria militaris*. The spores (or *conidia*) of the *Botrytis*-form and of the *Isaria*-form are capable of germination.

Bibl. Berk. *Hook. Br. Fl.* vi. pt. 2. p. 464; *Ann. Nat. Hist.* i. p. 259, vi. p. 132, pl. 12. fig. 12. 2nd ser. v. p. 464; Fries, *Summa Veget.* p. 464; Montagne, *Ann. des Sc. Nat.* 2 sér. v. pl. 12. fig. 3; Tulasne, *Ann. des Sc. Nat.* 4 sér. viii. p. 35.

ISARIA'CEI.—A family of Hyphomycetous Fungi, growing on decaying animal substances or larger Fungi, characterized by a cellular receptacle formed of filaments approximated together and conjoined throughout their whole length, each filament terminating in a spore. Recent observations throw doubt on the independence of this family, which perhaps consists simply of conidiiferous forms of other genera. See Isaria.

British Genera.

1. *Isaria.* Receptacle clavately branched, formed of densely interwoven coalescent filaments, or cellularly-fleshy. Spores borne on simple sporophores arising on all sides.

2. *Anthina.* Receptacle clavately branched, formed of parallel filaments, loosely interwoven or free, feathery or villous at the summit only, where they form the simple sporophores.

3. *Ceratium.* Receptacle somewhat horn-shaped, of a mucilaginous consistence, sprinkled with filaments which are surmounted by naked spores.

Bibl. See the Genera.

I'SIAS.—A genus of *Copepoda* (Entomostraca). 1 species. Bridlington Bay. Brady, *Ann. Nat. Hist.* 1872, vol. x. p. 3.

ISINGLASS.—This material consists of finely-divided shreds of the swimming-bladder of species of Sturgeon, and consequently exhibits structure under the microscope, consisting of a fibrous tissue with here and there fragments of blood-vessels &c. It is sophisticated with cut gelatine, which is structureless and moreover becomes more translucent when soaked in water, while isinglass becomes opaque and white.

Bibl. Hassall, *Food and its Adulterations*, p. 309.

ISOCHILI'NA, Jones.—An oblong equivalved Ostracode, belonging to the *Leperditiadæ*, and found only in the Silurian rocks of Canada, Russia, and Bohemia.

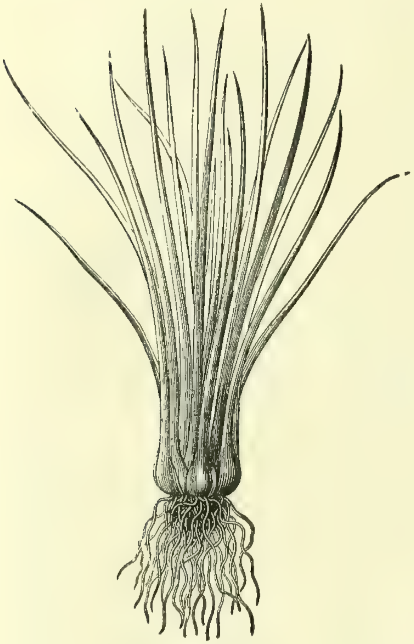
Bibl. R. Jones, *Ann. N. H.* 3, i. 248; Schmidt, *Mém. de l'Acad. St.-Pétersb.* xxi. 2.

ISOË'TES.—A genus of Psiloteæ (Lycopodiaceæ). *I. lacustris*, Quillwort, the only British species, occurs in mountain-lakes. *Isoëtes* is very remarkable in its mode of growth.

The woody substance of the stem of *Isoëtes*, like that of Lycopodiaceæ generally, is a solid central body, without a pith; it is surrounded by a thick parenchymatous rind, which makes up the greater part of the mass of the corm; the woody mass itself is cylindrical above, and somewhat hemispherical below, the convexity downward, and it has a layer of cambium not only over the growing apex, but over the convexity of the sides and lower surface. Every year a new portion of wood is added to the upper end, and also to the outer angle of the convex lower mass. The roots are produced in cycles of tens, sometimes one, sometimes two in a year; in each cycle the oldest root is the inmost; but the succeeding cycles appear in the middle of their predecessors, and push them out, and up to the side. The rind is renewed every year by the cambium layer; and the latter, in its growth to increase the size of the corm, by degrees covers up and encloses the remains of the earlier roots (as the woody layers of Dicotyledonous trees overgrow broken branches, bury them, and convert them into imbedded knots). The leaves are of delicate organization, and contain four longitudinal air-canals, with septa at intervals,

and one vascular bundle; they are expanded at the base, and contain the immersed sporanges. DeCandolle says the epidermis has stomata; this appears doubtful. The sporanges are of two kinds, or rather bear two kinds of spores; and there appears to be a periodicity in their development. The fronds of *I. lacustris* are discoverable in the inte-

Fig. 376.



Isoëtes setacea.
Natural size.

rior of the bud twelve months before they become fully developed; the sterile originate in spring and the earlier part of the summer, the fertile in the autumn, while stunted fertile leaves appear even in the winter. If a vigorous leafy plant be examined, it will be found to have a few sterile leaves outside, then a circle of leaves with oosporanges, next a circle of anthero-sporanges, and in the centre of the bud sterile leaves closing the annual cycle. The sporanges are somewhat plano-convex longish-oval cases, with transverse processes forming imperfect septa, dividing them into several chambers (fig. 378). The cases are sheathed by a membranous expansion of the base of the leaf (fig. 377), to which they are adherent by the back (fig. 378); the septa arise opposite the point of attachment at the back, and, spreading out, join the front wall. The different contents of the sporanges are evident before they open, those with the small spores (*anthero-sporanges*) having a smooth face, those with large spores (*oosporanges*) being rendered tubercular from the protrusion of the wall by the underlying bodies. The wall of the capsule is membranous and has no regular dehiscence,

Fig. 377.

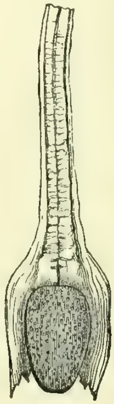


Fig. 378.

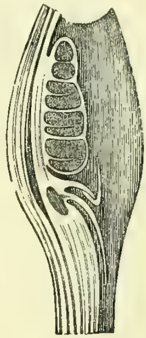


Fig. 379.

Isoëtes setacea.

Fig. 377. Base of a detached fertile leaf, seen in face. Magn. 5 diams.
Fig. 378. Vertical section, from back to front of ditto. Magn. 10 diams.
Fig. 379. Horizontal section, oosporange with macrospores. Magn. 10 diams.

the spores escaping by decay of the membrane in front.

The *smaller spores* resemble pollen grains; they are usually of the shape of quarters of a globe, more rarely tetrahedral, with an outer coat presenting ridges at the angles, and an inner which is a rounded sac. The outer coat is finely dotted in *I. lacustris.* The large *spores* are at first of a tetrahedral form with rounded angles, but when ripe they become globular. The delicate inmost layer is enclosed in a thick exospore composed of three layers; the innermost of moderate thickness, brown colour, and glassy consistence, exhibiting striæ and three strong ridges converging to a point at the angle where the spore meets its three sister

spores; the next coat is thinnish, and of granular character and yellow colour; the outermost is a clear and gelatinous layer: the outer two follow all the markings of the glassy coat, and are especially thick over the three ridges.

The contents of the *microspores* are at first merely granular protoplasm. About a month after they are scattered from the sporange, the protoplasm of the cell becomes divided into two or four portions, which form cells, in each of which again are developed two vesicles, each producing a filament coiled up spirally. The spores swell, the daughter cells burst, and the lenticular vesicles escape; the latter then open and emit the spiral filaments, which are found to be covered with cilia on the anterior turns of the spiral, by means of which they move actively through the water. They are the *spermatozoids.*

The *macrospores*, when they escape from the sporange, contain only protoplasm with oil-globules. In the course of a few weeks, the internal cavity of the spore begins to exhibit a development of cellular tissue, by which it is subsequently filled up. This is the *prothallium.* At the same time, the internal coat increases in thickness, and exhibits several layers. The increase of size of the prothallium causes the spore-coat to burst at the apex where the three ridges meet, so that three triangular valves turn back, exposing the prothallium. On this are developed the *archegonia*, the first on the apex in the central point where the three points of the spore-coat meet. If this is not fertilized, others are produced around it. The *archegonium* is of much the same character, essentially, as that of the rest of the higher Cryptogamous Plants, consisting of a papilla with a central canal leading to the embryo-sac. The four rows of cells forming the neck of the archegone separate, and a germ-cell is formed in the embryo-sac. This is fertilized by the entrance of a *spermatozoid* into the embryo-sac.

In the development of the embryo in the spore, it forms a cellular body, which gradually displaces the cellular tissue originally filling this up. The first leaf and roots are developed while the rudiment is still within the spore-coat, in opposite directions, and horizontally (right and left) in relation to the apex of the spore. The young plant somewhat resembles a germinating Monocotyledon.

The woody structure of the stem of *Isoëtes* consists of spiral-fibrous cells, usually annular or reticulated, but sometimes really spiral.

Carruthers has explained the resemblance of the method of the growth of *Isoëtes* and that of the gigantic Lepidodendron of the Carboniferous deposits.

Bibl. Bischoff, *Crypt. Gewäch. Rhizoc.* Nuremberg, 1828, p. 70; Mohl, *Verm. Schrift.* Tübingen, 1845, p. 122; Müller, *Botan. Zeit.* vi. p. 297, 1848 (*Ann. Nat. Hist.* 2 ser. ii. p. 81, &c.); Mettenius, *Beitr. z. Botanik,* 1st heft, Heidelberg, 1850; Hofmeister, *Abhand. d. K. Sachs. Ges. d. Wiss.* iv. 123; A. Braun, *Flora,* 1847, p. 33; Carruthers, *Lect. Royal Instit.* 1869; Henfrey's *Elem. Course* (Masters), 1870.

ISTH'MIA, Ag. — A genus of Diatomaceæ. Fam. Biddulphiaceæ.

Char. Frustules depressed or subcylindrical, rhomboidal or trapezoidal in front view, angles more or less produced; frustules coherent by the angles, basal frustule stipitate; surface of valves and hoop appearing reticular or cellular. Marine.

The depressions upon the valves and hoop are so large as to produce a distinct reticular or cellular appearance when viewed by ordinary illumination.

1. *I. obliquata* (*nervosa*, K.). British.
2. *I. enervis* (Pl. 13. fig. 2). British.

Bibl. Ehr. *Die Infus.* p. 209; Kütz. *Bacill.* p. 137, and *Sp. Alg.* p. 135; Ralfs, *Ann. Nat. Hist.* 1843, xii. p. 270; Rabenht. *Fl. Euro. Alg.* i. 309.

ITCH-INSECT. See Sarcoptes.

IVORY.—This substance, which consists of the tusks of the elephant, possesses the minute structure of the ivory of teeth.

IVORY, Vegetable.—This substance, consisting of the albumen of the seeds of a Monocotyledonous tree, *Phytelephas macrocarpa,* is composed of cellular tissue, with the walls so thickened by horny secondary deposits that the cavities of the cells are almost obliterated. The pores of the secondary deposits, however, remain uncovered throughout all the thickening, and thus are converted into tubes or canals running to meet each other from the small remaining cavities of contiguous cells. In Pl. 38, fig. 23 *c* represents a section mounted in Canada balsam, which has in part penetrated into the cavities; the remaining cavities and pore canals are filled with air and thus appear black (*a*).

IXO'DEA.—A family of Arachnida, of the order Acarina.

Contains a single genus, Ixodes.

IXO'DES, Latr.—A genus of Arachnida, of the order Acarina, and family Ixodea.

Char. Palpi canaliculate, sheathing the rostrum; mandibles three-jointed, basal joint internal, the second joint external and long, the third short, denticulate; labium covered with reflexed teeth; body very extensile, furnished near the rostrum with a dorsal horny shield; legs with two claws and a caruncle.

These animals form part of those which are popularly known as ticks. They are commonly found in dense woods, upon brushwood, briers, &c., from which they get upon animals, as dogs, oxen, horses, &c., burying the rostrum deeply in the skin and sucking the blood, so as to become distended to ten times their original size. They are also found upon reptiles, birds, and occasionally attack man.

The species are very numerous, and have been arranged in several genera by some authors. The following are the commonest genera:—

I. ricinus, the dog-tick. Body oval, in the gorged condition becoming globular and blackish violet; legs and appendages brown.

I. reduvius. Pale yellowish red; head and legs black. Found upon sheep.

I. pictus. Back white, with brown spots; crenulate posteriorly; legs brown. Found upon deer; also upon mosses.

I. Dugesii (*plumbeus*, Dug.) (Pl. 2. figs. 19–22). Oval, leaden grey, without spots. Found upon dogs.

I. plumbeus, Leach. Shield heart-shaped, slightly rugose; rostrum, palpi and legs pale ferruginous; body of a leaden colour; length 1-4″. Found upon and in the nests of the bank-swallow (*Hirundo riparia*).

BIBL. Gervais, *Walck. Aptères*, iii. p. 234; Hermann, *Mém. Aptér.*; Dugès, *Ann. des Sc. Nat.* 2 sér. ii.; Leach, *Linn. Trans.* xi.; Koch, *Uebers. d. Arach.*; Denny, *Ann. Nat. Hist.* 1843, xii.; Gené, *ibid.* 1846, xviii. p. 160; Macalister, *Qu. M. J.* 1871, p. 166.

J.

JANIA, Lamouroux.—A genus of Corallinaceæ (Florideous Algæ), calcareous filamentous bodies, occurring in tufts, pale red or purplish when fresh, on small Algæ between tide-marks. The filaments are articulated and dichotomously branched, impregnated with a calcareous deposit. The fruit consists of urn-shaped *ceramidia*, formed out of the end-joints of the branches, a dichotomous continuation of which is represented by a pair of minute divergent horns on the *ceramidium*; the latter is pierced by a pore at the apex, and contains a tuft of erect linear tetraspores. British species:

1. *J. rubens.* Joints of principal branches cylindrical. Harvey, *Phyc. Brit.* pl. 252.

2. *J. corniculata.* Joints of principal branches obconical and compressed, *l. c.* pl. 234.

BIBL. Harvey, *l. c.* and *Brit. Mar. Alg.* p. 107, pl. 13 D.

JATROPHA. See CASSAVA.

JONESIA. G. S. Brady, 1865.—A marine Ostracode. See BYTHOCYTH'ERE, G. O. Sars.

JONESIA.—A genus of Dicotyledonous plants (Leguminosæ). *J. asoca* is a beautiful Indian flower.

JUNGERMANNIA, Dill.—A genus of Jungermannieæ (Hepaticæ). Fructification terminal. Perichætial leaves free or united only at the base, like or unlike the stem-leaves. Perigone membranous, tubular, plaited-denticulate at the apex, the mouth three- or six-cleft. Vaginule membranous, included or rarely exserted. Capsule four-valved, splitting to the base. Amphigastria present or absent.

This is the largest genus of the Jungermannieæ; among the commonest species are *J. bicuspidata*, L., *J. albicans*, L., *J. barbata*, *J. setacea*, &c., found on wet bogs, banks, rocks, &c.

BIBL. Hooker, *Brit. Jungermanniæ*, *Brit. Flor.* i. pt. 1. p. 112, &c.; Ekart, *Synops. Jungermann.*; Nees v. Esenbeck, *Lebermoose*; Gottsche, Lindenberg, and Nees, *Synops. Hepatic.* Hamburg, 1844–47.

JUNGERMANNI'EÆ.—A family of Hepaticæ, distinguished by possessing a distinct stem, bearing leaves, often with stipule-like bodies called *amphigastria* (fig. 380), with terminal archegones, and sporanges bursting by four valves (figs. 320 and 321), destitute of a columella, containing elaters mixed with the spores.

The British genera may be grouped as follows:—

1. Leaves incubous (their bases covered by the tips of those below).
   - A. Leaves complicate, two-lobed.
     - *b.* Amphigastria present: *Lejeunia, Phragmicoma, Frullania, Madotheca, Ptilidium.*

c. Amphigastria absent. *Radula*.

A'. Leaves not complicate, two-lobed.

b. Amphigastrta present: *Trichocolea, Sendtnera, Schisma, Herpetium, Calypogeia.*

c. Amphigastria wanting. *Physiotium*.

Fig. 380.

Jungermannia albicans.

Stem with succubous leaves and amphigastria, and a lateral unopened perigone.

Magnified 10 diameters.

2. Leaves succubous (the bases covering the tips of those below).

A. Amphigastria present: *Saccogyna, Cheiloscyphus, Lophocolea, Sphagnocœtis, Jungermannia, Allicularia.*

A'. Amphigastria absent: *Plagiochila, Sarcoscyphus, Gymnomitrium, Haplomitrium.* See genera.

JUNIP'ERUS, L.—A genus of CONIFERÆ, presenting some interesting characters in the WOOD, the POLLEN, and the development of the OVULES.

JUTE.—The *liber* of *Corchorus capsularis*, Willdenow, an East-Indian plant belonging to the family of the Tiliaceæ, so many of which furnish fibrous substances (such as the *bast* used for matting, the liber of the lime-tree). Jute has a very long, glossy fibre, and is now largely imported into this country. Pl. 21. fig. 3 represents the single liber-fibres (see FIBROUS STRUCTURES and LIBER).

BIBL. Hooker, *Journ. of Bot.* vol. i. 25. 1849.

K.

KALLYME'NIA, J. Ag.—A genus of Cryptonemiaceæ (Florideous Algæ), fleshy membranous sea-weeds of red colour, with ribless leaf-like fronds, having three strata of cellular tissue, the central filamentous, the intermediate of large round cells, the cortical of minute cells in vertical rows. Fructification: spherical masses (*favellidia*) of *spores* half immersed in the frond, and *tetraspores*, which are tetrahedrally subdivided, and occur scattered. The two British species, *K. reniformis* and *Dubyi*, are both rather rare.

BIBL. Harvey, *Brit. Mar. Alg.* p. 150, pl. 19 B; *Phyc. Brit.* pl. 13. 123; *Engl. Bot.* pl. 2116.

Fig. 381.

Kaulfussia. A sorus. Magn. 25 diams.

KAULFUSSIA, Blume.—A genus of Marattiaceous Ferns, with curious roundish sori, formed of radiately coherent sporanges, opening by a slit at the top (fig. 381). Exotic.

KERO'NA, Müll., Ehr.—A genus of Infusoria, of the family Oxytrichina.

Char. Body covered with cilia, hooks also present, but no styles.

K. polyporum, Syn. *Stylonichia polyporum* (Pl. 41. fig. 13). Body whitish, depressed, elliptico-reniform, with a row of longer cilia in front below the mouth; length 1-144''. Parasitic upon *Hydra*.

BIBL. Ehr. *Infus.* p. 368; Duj. *Infus.* 422; Claparède et Lach. *Etudes sur les Infus.* pp. 69, 161.

KERO'NIA.—A family of Infusoria (Duj.).

Claparède and Lachmann have redistributed the genera of this too inclusive family; and it therefore does not exist in their classification. It is resolved into the OXYTRICHINA and HALTERINA.

KIDNEY.—The kidney consists of its enveloping membrane and the secreting parenchyma.

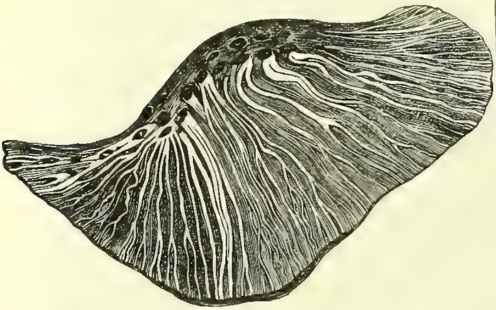
The membrane is a firm fibrous coat, called the capsule. It is composed of condensed areolar tissue, and is continuous with that constituting the matrix of the kidney, in the meshes of which are the uriniferous tubes and blood-vessels. At the concave edge of the kidney (the hilum) this fibrous capsule is continuous with the outer coat of the pelvis of the kidney, and also with the sheath of the blood-vessels.

The parenchyma, in a transverse section, appears to the naked eye to consist of two parts, the inner or medullary substance, and the outer or cortical. The medullary substance is composed of 8–15 isolated conical masses or pyramids, converging towards the hilum, and their apices forming the papillæ;

whilst the cortical substance constitutes the outer part of the organ, and fills up the interstices between the pyramids. When microscopically examined, the cortical part also becomes resolved into as many segments as there are pyramids; hence the kidneys may be regarded as composed of a certain number of intimately connected lobules.

Both the cortical and the tubular substance consist principally of the urinary tubules. These commence in each segment or lobule by very numerous orifices on the surface of the papillæ, and pass through the pyramids,

Fig. 382.



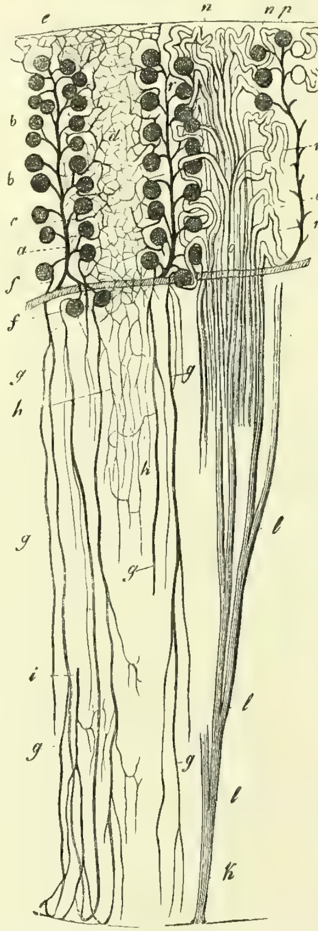
Papilla of the kidney of a pig with the tubules injected, showing their origins upon the surface.

Magnified 10 diameters.

running straight and nearly parallel with each other (fig. 383 *h'*). During this course they undergo repeated dichotomous subdivision (fig. 383 *l*), the branches being given off at a very acute angle, and at first with considerable diminution in size; and sometimes they divide into three or four branches, so that ultimately a larger bundle of tubes proceeds from them, producing the increased breadth of the pyramids towards the exterior. Towards the base of the pyramids, the parallel tubules become more loosely connected by the interposition of bundles of arteries and veins (which run straight) and they diverge in all directions, pursuing an undulating course. On reaching the cortex, the tubules branch off and increase in diameter, becoming also very tortuous; then they turn downwards, diminish in breadth, and run parallel with their first course. They then form a curve, the loop of Henle, and run upwards again, and finally become tortuous and enlarged before terminating in Malpighian corpuscles.

The nature of the minute anatomy of the *tubuli uriniferi* is still a matter of dispute. Ludwig gives the following account

Fig. 383.



Perpendicular section of the injected kidney of a rabbit through part of a pyramid. On the left the course of the vessels, on the right that of the tubules is shown. *a*, interlobular arteries, with their Malpighian tufts *b*, and vasa efferentia *c*; *d*, capillaries of the cortical portion; *e*, vasa efferentia of the outermost tufts, passing to the surface of the kidney; *f*, vasa efferentia of the innermost tufts, running into the straight arteries, *g*, *g*, *g*; *h*, capillaries of the pyramids, arising from the latter; *i*, a straight vein commencing at the papilla; *h'*, origin of a urinary tubule at a papilla; *l*, *o*, branches of the same; *m*, coiled portion in the cortex; *n*, the same at the surface of the kidney; *p*, connexion with the Malpighian capsules.

Magnified 30 diameters.

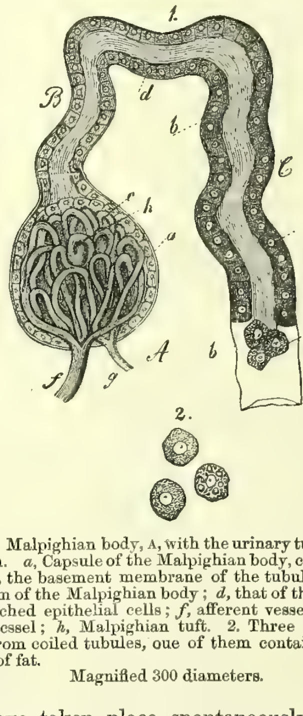
of it:—As often as the tubuli change their diameter and direction, they also become

altered in structure. The spherical capsule of the Malpighian body, after being subjected to the action of nitrate of silver and carmine (in the rabbit for instance), consists, so far as it can be broken up, of a mosaic of cells closely resembling those composing the wall of the blood and lymphatic capillaries. From the neck of the capsule to the commencement of the large tubules which result from the union of groups of tubules, and which, from their large calibre and short course in the papillæ, are called papillary ducts, the wall is composed of a basement membrane, the inner surface of which is lined by an epithelium. In general the membrane is homogeneous; it is as clear as glass, presents now and then, under reagents, nuclei, and swells up in water. The epithelium lining the capsule forms a single layer, and is nucleated; and in the tortuous parts of the tubules, the nuclei, which are very equally distant, are imbedded in a pulpy mass. This epithelial pulp is divided by fissures, which may be penetrated by injected colouring-matters; but it does not appear that the pulp is really differentiated into separate cells.

The epithelial pulp is only loosely attached to the basement membrane, so that when fresh it can be easily forced out of the isolated and divided tubules. How far the epithelial mass projects into the tubules, depends on their distention. It is not homogeneous, but presents numerous fat-drops and dark granules which clear off under acids. These particles occasion a degree of cloudiness that is usually sufficient to conceal the nucleus; hence the term of "cloudy epithelium," which is applied to that of the tortuous parts of the tubules where they are large in calibre. In the slenderer parts of the tubes, on either side of the loop of Henle, the epithelium is in a thin and continuous layer, which projects here and there owing to the presence of nuclei. In the portions of the tubules which form the first enlarged and tortuous portions, the shape of the mass investing the nuclei is again altered. A split makes its appearance about halfway between every two nuclei, which is open towards the wall and pointed towards the base of the tube. The epithelium in consequence appears to be composed of clear separate columnar cells. In the upper tubes of the medullary portion, the epithelium is composed of columnar cells, and in the ductus papillares the epithelium exists without the basement membrane.

The former explanation of the minute anatomy, and which is still held by many, is as follows:—The urinary tubules are cylindrical, and consist of a basement membrane (fig. 384 *b*) lined with pavement epithelium, *d*. The basement membrane is very transparent, but firm and elastic. Within it is a single layer of nucleated polygonal epithelial cells (fig. 384 *d*, *e*). These, when immersed in water, lose their polygonal form, become rounded, and appear to fill up the tubules entirely; they often also burst, and then the tubules appear to contain nothing more than a finely granular mass with nuclei. These changes are found

Fig. 384.



1. A Malpighian body, A, with the urinary tubule B C; human. *a*, Capsule of the Malpighian body, continuous with *b*, the basement membrane of the tubule; *c*, epithelium of the Malpighian body; *d*, that of the tubule; *e*, detached epithelial cells; *f*, afferent vessel; *g*, efferent vessel; *h*, Malpighian tuft. 2. Three epithelial cells from coiled tubules, one of them containing globules of fat.

Magnified 300 diameters.

to have taken place spontaneously if the kidney is not fresh. The epithelial cells are larger in the convoluted than in the straight tubules (fig. 384, 2).

The Malpighian bodies may be regarded as terminal dilatations of the tubules, each containing a round plexus of vessels, the Malpighian tube.

The basement membrane surrounding the tuft (fig. 384 *a*) is somewhat thicker than

elsewhere; and the epithelium lining it is continued over the free surface of the tuft. This is denied by Bowman. The Malpighian tufts consist of close convolutions of fine vessels derived from branches of the renal artery. The latter enter the kidney between the pyramids, and continue to divide until arriving at the cortical substance, where they give off a number of long branches, mostly running towards the convex surface of the kidney, between the lobules, hence called interlobular arteries. From these, short (mostly lateral) branches are given off, each of which terminates in a Malpighian tuft, forming its afferent vessel. Each afferent vessel, on entering the Malpighian body, divides into 5–8 branches, each of

Fig. 385.

From a human kidney. *a*, end of an interlobular artery; *b*, afferent vessels; *c*, naked Malpighian tuft; *ä*, efferent vessels; *e*, tufts enclosed in their capsules; *f*, urinary tubules arising from them.

Magnified 45 diameters.

which becomes subdivided into a tuft of capillaries; these are variously convoluted and interwoven, ultimately uniting in a single vessel, the efferent vessel. The afferent and efferent vessels are usually situated near each other, and opposite the origin of the urinary tubule.

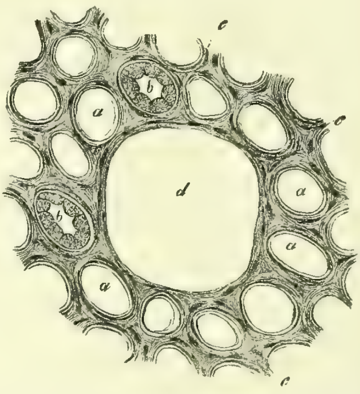
The efferent vessels, which, although arising from the capillaries of the Malpighian tufts, are rather small arteries than veins, in import and partly in structure, terminate in the capillary network situated in the cortical substance and the pyramids. This network closely surrounds the coiled tubules on all sides, and forms a connected plexus throughout the kidneys, the meshes of which are roundish-angular; but near the pyramids the afferent vessels are larger, and differ from the rest in their straighter course and more sparing ramification.

The veins of the kidney commence on the surface of the organ and at the apices of the papillæ by small branches connected with the plexus; these by their union form larger ones, which accompany the larger arteries.

Mr. Bowman compares the solitary efferent vessels of the Malpighian bodies to the portal system of the liver, both serving to convey blood between two capillary systems. He describes these efferent vessels collectively as the portal system of the kidney.

The interstices between the vessels, nerves, and tubules of the kidney are occupied by a stroma of areolar tissue (fig. 386 *c*), contain-

Fig. 386.



Transverse section of some cortical urinary tubules; human. *a*, divided tubules, with the epithelium removed; *b*, the same, containing the epithelium; *c*, stroma of areolar tissue; *d*, space corresponding to a Malpighian body.

Magnified 250 diameters.

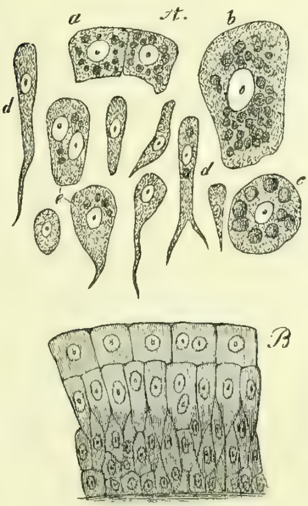
ing elongated nuclei, and which is much more abundant in the medullary than in the cortical portion. At the surface this frequently becomes condensed to form a very distinct membrane, but loosely adherent to

the fibrous capsule, and which is connected by numerous delicate processes with the inner stroma.

The pelvis of the kidney with the calyces and the ureter consist of an outer fibrous, a muscular, and a mucous coat. The fibrous coat is composed of ordinary areolar tissue, mixed with elastic tissue.

The mucous coat is thin, and not furnished with glands or papillæ. Its epithelium (fig. 387 B) is laminated, and remarkable for the variable form and size of its elements (fig. 387 A), the deeper cells being roundish and small, those in the middle cylindrical or conical, and the uppermost roundish, polygonal, and somewhat flattened. The cells frequently contain two nuclei, and bright rounded granules with dark margins.

Fig. 387.



Epithelium of the pelvis of the kidney; human.

A. Isolated cells: *a*, small, *b*, large pavement-epithelial cells; *c*, the same containing the granules; *d*, cylindrical and conical cells from the deeper layers; *e*, intermediate forms. B. Cells *in situ*.

Magnified 350 diameters.

Lymphatics accompany the blood-vessels of the hilum, and they exist between the groups of tortuous tubules in the cortex; and the nerves penetrate the kidney with the vessels and present ganglia in their course.

In the Mammalia generally the structure of the kidneys agrees essentially with that of man.

In the lower Vertebrata they exhibit differences which relate principally to the following particulars:—1, the form, which in birds, fishes, and reptiles is considerably more elongated and frequently flattened; 2, the lobulation, which in the human adult kidney is indistinct, although marked in the fœtus, whilst in that of other Vertebrata the separate lobules are very distinct, sometimes being connected only by the branches of the ureter; 3, the Malpighian tufts, which in birds, reptiles, and fishes consist of a single convoluted vessel, and which in some (naked reptiles) are larger, in others (osseous fishes) smaller than in man, whilst in birds (also the sheep) they have been found inserted into the sides of the tubules; and 4, in the structure and arrangement of the urinary tubules; these are uniform in size in fishes, furnished with ciliated epithelium in the reptiles and fishes, and present varieties in regard to the convolution, branching, and termination in the ureter.

Renal organs have been noticed in the Cephalopoda, Mollusca, Insecta, and Arachnida.

The epithelial cells of the urinary tubules are not unfrequently found to contain the ordinary urinary deposits, which are more often still met with in the cavities of the tubules. Many of these are probably, however, formed after death (see URINARY DEPOSITS).

Among the morbid changes of the kidney, passing over cancer, tubercle, variations in the degree of vascularity, the presence of calculi, and the ordinary products of inflammation, may be mentioned the occurrence of cysts. These are met with of various size and in variable number. They may contain a serous liquid, a yellowish colloid substance, or a consistent albuminous matter with concentric bodies, and may occur in a kidney otherwise healthy, or when affected with Bright's disease. The walls of the cysts do not differ in structure from those of the tubules, except in being thickened; they have been accounted for as arising from dilatation of the tubules or Malpighian capsules, in consequence of obstruction to the escape of the urine, distention of the epithelial cells of the tubules, and degeneration of their nuclei, forming colloid cells. The first is probably the general cause, and certainly an occasional one, the Malpighian tufts having been found within the enlarged cysts after injection. Sometimes the cysts are those of

Echinococci. In Bright's kidney the tubules are found deprived of their epithelium, the cells filled with albuminous, fibrinous, or fatty matter, and the fibrous tissue increased,—in the advanced stage both becoming undistinguishable in some parts, whilst in others cells and tubules are loaded with fatty globules, producing the well-known granular appearance.

In examining the structure of the kidney, sections must be made with a Valentin's knife. The arrangement of the vessels may be shown by injection; and the injected preparations are very beautiful, and form general favourites. The Malpighian bodies are readily filled, the injection being thrown into the artery; and they are readily recognized by their resemblance to little apples upon the branches of a tree, or bunches of currants. The injection should be red. If the injection be coarse, it will burst through the capillaries of the tufts, and partially fill the tubules, as in fig. 383 *p*; but if it be fine, it will fill the venous plexus. The urinary tubules should be injected from the ureter, white (lead) injection being used; and considerable force is required to make a good injection, but this must be very gradually applied. Pl. 31. fig. 35 is intended to represent a portion of the kidney of a pig. The kidneys of the smaller and lower animals are best injected from the heart. The usual staining processes are very useful.

Bibl. Kölliker, *Mik. Anat.* ii. and the *Bibl.*; Bowman, *Phil. Trans.* 1842; Johnson, *Todd's Cyclop. of Anat. and Phys.*, art. *Ren*; Toynbee, *Med. Chi. Trans.* xxx.; Förster, *Handb. d. Path. Anat.*; Frerichs, *Die Brightsche Nierenkrankheit, &c.*; Gairdner, *Edinb. M. Journ.* viii.; Todd and Bowman, *Phys. Anat.* 1859; Henle, *Anat. d. Nieren, Abh. der k. Gesells. der Wiss. in Göttin.* Bd. x.; C. Ludwig, *Wiener Akad. Sitz.* Bd. xlviii.; Gross, *Essai sur la Structure Mic. du Rein*, Strasbourg, 1868; Frey, *Das Mikr.* p. 289, 1865, and *Handb. d. Histol.* 1870, p. 507.

KIRK'BYA, Jones.—A small bivalved Entomostracan, of the Leperditiadæ family, and nearly allied to *Beyrichia*. The valves ridged longitudinally and concentrically, often reticulated superficially, and impressed with a subcentral pit. Fossil in the Palæozoic rocks, from the Silurian to the Permian, and often very abundant.

Bibl. Rupert Jones, *Tr. Tyneside Nat. Club*, iv. p. 134; *Ann. N. H.* ser. 4, iii. p. 223.

KNIFE, VALENTIN'S. Introduction, p. xxiii.

KONDYLOS'TOMA, Duj.—A genus of Infusoria, of the family Bursarina.

Char. Body elongated, cylindrical or fusiform, slightly arcuate, the ends obtuse and depressed, with a very large mouth margined with stout cilia, and situated laterally at the anterior end; surface obliquely striated and ciliated.

K. patens (Pl. 24. fig. 31; fig. 32, slightly compressed).

Bibl. Duj. *Infus.* p. 516; Clap. et Lach. *Etudes*, p. 244.

KRAUSE'S CORPUSCLES.—The terminal bulbs of the nervous plexus and interlacing nerve-fibres of the conjunctiva. They consist of a connective-tissue sheath with nuclei, an internal bulb of finely granular dull-shining material, and in the interior of this a pale terminal fibre with a somewhat thickened end.

Bibl. Krause, *Ueber term. Körper*, 1868; Stricker, *Hum. & Comp. Hist.* v. 3. p. 453.

L.

LABREL'LA, Fr.—A genus of Phacidiacei (Ascomycetous Fungi), growing upon living leaves. *L. Ptarmicæ*, Desm., grows upon the leaves of *Achillea Ptarmica*.

Bibl. Berk. *Ann. Nat. Hist.* i. p. 208, pl. 7. fig. 7; Fries, *Summa Veg.* p. 422.

LABYRINTHODON'TA.—A group of extinct Amphibia. The teeth of the species of the numerous genera of this group are beautiful microscopic objects when cut in transverse sections. They have a resemblance to corresponding sections in the extinct fish *Dendrodus*. The teeth are large and conical, and are grooved longitudinally after the fashion of the Ichthyosauria. These grooves are inflections of the substance, and in transverse sections are continuous with long wavy lines, which lead down close to the pulp-cavity, from which other lines spread out and ramify. The result is a labyrinthic appearance.

Bibl. Owen, *Odontography*.

LABYRIN'THULA, Cienkow.—A genus or group of Protista. The forms are microscopic and are thin, reticulate, colourless filaments, on which fusiform bodies circulate very slowly in various directions. The filaments arise from imbedded globular fusiform masses. There are two species.

Bibl. Cienkowski, *Arch. für mik. Anat.* iii. p. 374.

LACE-BARK. See Thymeleaceæ.

LACINULARIA, Oken.—A genus of Rotatoria, of the family Floscularиæa.

Char. Eyes two (when young); urceoli or gelatinous sheaths aggregated into a spherical mass; rotatory organs with two lobes.

L. socialis (Pl. 41. fig. 15). Urceoli gelatinous, yellowish; rotatory organ very broad, in the form of a horseshoe; aquatic; length 1-36″.

BIBL. Ehrb. *Infus.* p. 403; Huxley, *Microsc. Journ.* 1852; Leydig, *Siebold und Köll. Zeit.* 1852; Ukedem, *Ann. des Sc. Nat.* 3 sér. 1851; Cubitt, *M. Mic. Jn.* 1872–73.

LACRYMA'RIA, Bory.—A genus of Infusoria, of the family Trachelina, Clap. et Lach.

Char. Body rounded behind, not ciliated; with a long and slender neck, which is dilated at the end, and furnished with a ciliated mouth and a lip, but no teeth (= *Trachelocerca* without a tail).

L. proteus, syn. *L. olor.* Body oblong, turgid, colourless, with delicate oblique striæ; neck very long; aquatic; length 1-140″.

Two doubtful species; one (*L. gutta*) colourless and without striæ; the other (*L. rugosa*) containing green matter, with the body wrinkled. Claparède describes two other species.

BIBL. Ehrb. *Infus.* p. 309; Duj. *Infus.* p. 468; Clap. et Lach. *Etudes.*

LACTA'RIUS.—A genus of Hymenomycetous Fungi, distinguished from *Agaricus* by the inner substance of the gills (trama) being vesicular instead of filamentous. Most of the species abound in milky juice; and several of them are esculent. Amongst the most approved is *L. deliciosus,* remarkable for its bright orange-coloured milk. Some acrid species, however, as *L. piperitus,* are largely consumed in Russia, having first in general been preserved in salt and vinegar.

BIBL. Fr. *Epicr.* p. 333; Berk. *Outl.* p. 203; Cooke, *Handb.* p. 206.

LACTATES. See the bases, lactate of lime (Pl. 7. fig. 19), lactate of zinc (Pl. 7. fig. 20).

LACTEALS. See VILLI.

LÆMAR'GUS, Kröyer.—A genus of Crustacea, of the order Siphonostoma, and family Cecropidæ.

L. muricatus. Found upon the sun-fish (*Orthagoriscus molæ*). Length of female 1″; male much smaller.

BIBL. Baird, *Brit. Entomos.* p. 293.

LAFO'ËA, Lamx.—A genus of Lafoëidæ, of the suborder Thecaphora (or Hydroida with true calycles).

Char. Stem a simple creeping tubular fibre, or erect and composed of many tubes aggregated together, rooted by a filiform stolon; hydrothecæ tubular, sessile, or with a short pedicel; without an operculum; polypites cylindrical, with a conical proboscis. There are five British species.

BIBL. Hincks, *Brit. Zooph.* p. 198.

LAFOË'IDÆ.—A suborder of Hydroida. See LAFOËA.

LAGE'NA, Walker & Jacob. A unilocular (rarely bilocular) hyaline Foraminifer, of the Nodosarine group, generally flask-shaped. The shell may be subglobular, oval, oblong, or fusiform; round, compressed, or angular in section; variously ornamented with ribs, network, tubercles, and spines; open at one or both ends, with or without a neck, and often with the tube turned inwards (Entosolenian). Recent and fossil all over the world. *Lagena lævis* (Pl. 18, f. 22) is a typical and very common form. *L.* (*Entosolenia*) *globosa* (f. 23) with the neck-tube introverted, is another very common variety. *L. striata* (f. 24) is an elongato-apiculate variety, delicately costulate. *L. semistriata* (f. 25) is *L. globosa* with short basal ribs. *L. squamosa* (f. 26) was so called because the early microscopes showed the pitted reticulation as raised scales. *L. scalariformis* (f. 27) has a bold hexagonal mesh ornament. The last is recent, and the others are both fossil and recent.

BIBL. Carpenter, *Introd.* 156; Parker & Jones, *Phil. Trans.* clv. 345; P., J. & Brady, *Mon. Crag Foram.* 28.

LAGENEL'LA, Ehr.—A genus of Infusoria.

L. euchlora (Pl. 24. figs. 35 & 36).

It is probably the spore of an Alga.

BIBL. Ehrb. *Infus.* p. 45; Duj. *Infus.* p. 333.

LAGE'NOPHRYS, Stein.—A genus of Vorticellina (Infus. Ciliata).

Char. Sheathed Vorticellina; attachment to the circumference of the sheath's mouth. Three species.

BIBL. Stein, *Infus.* p. 88; Pritchard, *Infus.* p. 604; Claparède et Lach. *Etudes.*

LAGO'TIA, Wright. See FREI'A, Clap. et Lach.

BIBL. S. Wright, *Edin. Phil. Jour.* 1858; Claparède et Lachmann, *Etudes,* p. 467.

LAGY'NIS, Schultze.—A genus of Rhizopoda. Fam. Actinophryina. It forms the type of Schultze's group of Lagynida. The genus should be absorbed into *Euglypha,* Duj.

BIBL. Claparède et Lach. *Etudes*, p. 456.

LAMINA'RIA, Lamx.—A genus of Laminariaceæ (Fucoid Algæ), with large, flat, stipitate fronds, several species of which are common on rocky shores, attached to rocks and stones. *L. saccharina* has a riband-shaped frond, growing from 2 to 12 feet long. *L. digitata* has a broad frond, 1 to 5 feet long, cut into a variable number of segments. The internal structure presents three layers, the outermost forming a kind of epidermis. The *sporanges* (spores of authors), containing ciliated zoospores which reproduce the plant, are the only kind of fructification yet observed. They are little elongated sacs, nestling between epidermal cells of peculiar structure, standing perpendicularly upon the central substance of the frond. In *L. saccharina* the presence of the sporanges is denoted by a longitudinal brown mark in the centre of the frond; in *L. digitata* they occur in flat patches on the extremities of the digitations. The zoospores are little olive-coloured bodies, with an anterior and posterior cilium. Thuret has seen them germinate.

BIBL. Harvey, *Brit. Mar. Alg.* p. 29, pl. 4; *Phyc. Brit.* pl. 192, 223, 241, &c.; Greville, *Alg. Brit.* t. 5; Thuret, *Ann. des Sc. Nat.* 2 sér. xiv. p. 240, pl. 30. figs. 1–4; Henfrey, *Elem. Cour.* (Masters) 1870.

LAMINARIA'CEÆ.—A family of Fucoideæ. Phæosporeæ in part. Olive-coloured inarticulate sea-weeds, whose sporanges are superficial, either forming indefinite cloud-like patches, or covering the whole surface of the frond. See genera ALARIA, LAMINARIA, and CHORDA.

LAOMEDE'A, Lamx.—A genus of Hydroida, and family Campanulariadæ.

Syn. Obelia.

Six British species: *dichotoma* (ovicell, Pl. 33. fig. 4 *c*), *geniculata, gelatinosa, obliqua, Flemingii*, and *lacerata*. Found upon marine Algæ, stones, &c., between tide-marks.

BIBL. Johnston, *Brit. Zooph.* p. 101; Gosse, *Mar. Zool.* ii. 24; Hincks, *Brit. Zooph.*

LAR, Gosse.—A genus of Thecaphorous Hydroida.

Char. Polypites fusiform, sessile, with two tentacula springing from the base of a bilobate proboscis, developed on a creeping and anostomosing stolon.

1 species, *Lar sabellarum*. The polypites bear a close resemblance to the human figure. Probably an abnormal form.

BIBL. Gosse, *Linn. Trans.* xxii. 113, tab. xx.; Hincks, *Brit. Zooph.* p. 36.

LAREL'LA, Ehr.—A genus of Rotifera, fam. Brachionea.

Char. Body with equal setæ and three long fine hairs on each side of mouth; two frontal eyes; length 1-190 to 1-280″.

BIBL. Pritchard, *Infus.* p. 712.

LARVÆ.—In animals which pass through certain marked stages of development, or undergo metamorphosis, as it is called, the condition in the first of these stages is called the larval state, and the animal itself is called a larva.

The aquatic larvæ of several insects are well-known microscopic favourites on account of their transparence, which allows the action of the dorsal vessels, with the circulation of the nutritive liquid, to be seen, and their curious respiratory organs. A few of the more common aquatic larvæ and their parts are represented in Pl. 28. figs. 1, 14–17, 19–22, 29; these are noticed more in detail under their respective heads.

The aquatic larvæ of some amphibia are admirable objects for exhibiting the circulation of the blood, the development of tissues, &c., as those of the frog (tadpoles) and of the *Triton*.

LASIOB'OTRYS, Kz.—A genus of Perisporacei (Ascomycetous Fungi).

L. Loniceræ grows on the living leaves and stems of various kinds of Honeysuckle, forming little heaps seated on a tuft of radiating filaments. The so-called peridioles appear to be sclerotioid bodies, the superficial cells of which are converted into true perithecia, becoming free on the surface: these contain numerous asci when mature; but the spores have not been observed.

BIBL. Berk. *Brit. Flora*, ii. pt. 2. p. 324; *Ann. Nat. Hist.* 2 ser. ix. p. 386, pl. 12. fig. 44; Fries, *Summa Veg.* p. 406; Greville, *Sc. Crypt. Fl.* pl. 191.

LASTRÆA, Presl.—A genus of Aspidieæ (Polypodioid Ferns), containing a number of British species, such as *L. Filix-mas, dilatata*, &c., separated from *Aspidium* on account of the reniform indusium, and distinguished from *Nephrodium* by the veinlets being free at the ends.

LATEX.—The name applied to the peculiar juices, becoming milky when exposed to air, contained in the 'milk-vessels,' or *laticiferous canals* of plants, especially abundant in Euphorbiaceæ, Papaveraceæ, Cichoraceæ, &c. It appears to consist of a watery fluid, with albumen in solution, in which float globules of caoutchouc, or analogous gum-resinous matter, of variable size,

occasionally mixed with starch-granules of peculiar forms, as in *Euphorbia* (Pl. 39. fig. 23). According to Sachs and Hanstein it is a fluid which contains matters of a directly nutritive character and others which are excrementitious in their nature. Trécul, on the other hand, appears to consider that the latex is the residue of the sap after elaboration by the cells. See LATICIFEROUS TISSUE.

BIBL. Schultz, *sur les vaisseaux laticifères dans les Plantes*, Paris, 1841; Von Mohl, *Ueb. den Milchsaft*, &c., *Botan. Zeit.* 1843; *Ann. Nat. Hist.* xiii. 441.

LATHONU'RA, Lilljeborg.—A genus of Macrothricidæ (Entomostraca).

Char. Carapace obovate, not produced, ventral margin furnished with peculiar flattened spear-shaped plates attached to the edge. 1 Irish species.

BIBL. Norman & Brady, *Monogr. on Bosminidæ, &c.*, *Nat. Hist. Tr. Northumb.*

LATHRÆA.—A genus of Orobanchaceous Flowering Plants. *L. squamaria*, a remarkable plant, found here and there in beech-woods in England, has been the subject of much research as regards embryology, by Schacht and others. See OVULE.

LATICIFEROUS TISSUE, DUCTS, CANALS, OR VESSELS.—These names are applied to the tubular and often ramified canals in which is contained the milky juice or *latex* of many plants (figs. 388, 389). The nature, or rather the origin, of these canals is still a matter of dispute. The ducts present themselves in various forms and conditions, especially in the rind and pith in the Apocynaceæ, Asclepiadaceæ, Moraceæ, Urticaceæ, Papaveraceæ, Cucurbitaceæ, Euphorbiaceæ, Aroideæ, &c. Simple unbranched milk-vessels occur in the pith of the elder.

Fig. 388.

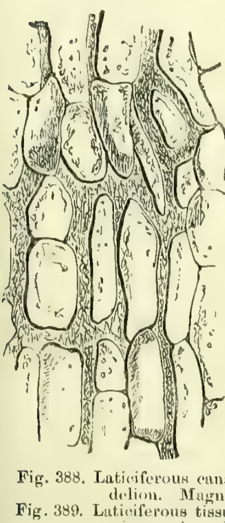


Fig. 389.

Fig. 388. Laticiferous canals from the root of Dandelion. Magn. 100 diams.
Fig. 389. Laticiferous tissue extracted from *Chelidonium majus*. Magn. 100 diams.

Schacht regards them all as liber-cells. The opinion which we share with almost all other vegetable anatomists is, that they are intercellular passages, originally devoid of a proper coat, but subsequently acquiring one of variable thickness, derived apparently from the secretion which they contain. Unger, however, imagines that, while some are formed in this way, they are mostly developed out of confluent rows of cells, like the dotted ducts; and Trécul is of opinion that they are ordinarily formed in this way. Dippel considers that they replace the clathrate cells of other plants. They require much further investigation.

Canals bounded by a defined coat of cellular tissue, forming intercellular canals or ducts of very definite character, occur in the Coniferæ, the Guttiferæ, Anacardiaceæ, &c. These will be spoken of under RECEPTACLES FOR SECRETIONS.

Canals containing a milky juice occur in some of the Fungi, as in the fleshy substance of *Agaricus deliciosus*, *quietus*, and others of the same section.

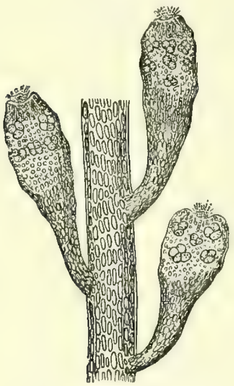
It was declared some years ago by Schultz that a regular circulation of the latex takes place through the ramified laticiferous ducts. This was chiefly supported on observations of movements of the latex which may be made on tolerably transparent parts of living plants containing these ducts. By bringing the uninjured sepal of *Convolvulus* or a leaf of *Chelidonium* under the microscope (placing it in oil is advantageous in the latter case), the branched latex-ducts may be made out, and a flowing movement of the particles may be seen occasionally. But this has been shown to depend upon a disturbance of the equilibrium by external causes, such as pressure and heat, and may be produced at will in any direction by making an incision, towards which the juice flows. Trécul thinks that the laticiferous canals communicate freely with the pitted ducts and other vascular elements, and take a share in a kind of circulation, wherein they play the part of venous reservoirs; but his views do not appear to us well-founded.

BIBL. Schleiden, *Princip. of Bot.* (Lon-

don, 1849), p. 64; Unger, *Grundzüge der Anat. und Phys.* (1846), p. 54; Schacht, *Botan. Zeit.* ix. p. 513. 1851; *Die Pflanzenzelle*, p. 210. Berlin, 1852; *Monat. Berlin Akad.* Nov. 1856; *Flora*, 1857, p. 89; Meyen, *Secretionsorgane*, p. 63. Berlin, 1837; Trécul, *Ann. des Sc. Nat.* 4 sér. vii. p. 290; Henfrey, *Elem. Cour.* (Masters) 1870.

LAURENCIA, Lamx.—A genus of Laurenciaceæ (Florideous Algæ), containing several British species, mostly common, of yellowish-green, purple or pink colour, the fronds pinnately branched, of solid parenchymatous structure. The *ceramidia* are borne on the smaller branches, as are also the *antheridia*; the *tetraspores* are imbedded in the ramuli (fig. 390). The *ceramidia* contain tufts of pear-shaped spores; the tetraspores are tetrahedrally divided. The antheridia are thus described (in *L. tenuissima*) by Thuret: on the smaller branches, similar to those which bear the *ceramidia* on other individuals, occur greyish convoluted plates of cellular tissue, of irregular form, bordered by a line of roundish cells, containing generally a yellow liquid. Hyaline cells containing antherozoids are implanted vertically on these plates, clothing both surfaces. The antheridium has a sort of pedicel formed of an ovoid cell, which also bears a dichotomous hair, like those common over the branches of this plant. The antherozoids are elongated-ovoid, a little constricted at one extremity, length about 3-5000″. MM. Derbès and Solier have observed them on *L. pinnatifida* and other species.

Fig. 390.



Laurencia dasyphylla.
Ramuli containing tetraspores.
Magnified 50 diameters.

BIBL. Harvey, *Brit. Mar. Alg.* p. 97, pl. 12 C; *Phyc. Brit.* pl. 55, &c.; Grev. *Alg. Brit.* p. 108, pl. 14; Derbès and Solier, *Ann. des Sc. Nat.* 3 sér. xiv. p. 276, pl. 37; Thuret, *ib.* xvi. p. 65, pl. 7, *ib.* sér. 4. iii. p. 19.

LAURENCIA'CEÆ.—A family of Florideæ. Rose-red or purple sea-weeds with a cylindrical or compressed, rarely flat, linear, narrow, areolated, inarticulate, or constricted and chambered, branching frond composed of polygonal cells. *Fructification*: 1, *conceptacles* (*ceramidia*) external ovate, furnished with a terminal pore, and containing a tuft of pear-shaped spores; 2, *tetraspores* immersed in the branches and ramuli, scattered without order through the surface cells; 3, *antheridia*. Pringsheim states that the tetraspores are gonidia, and grow up into a new thallus.

British genera. See BONNEMAISONIA, LAURENCIA, CHRYSIMENIA, CHYLOCLADIA.

LEA'IA, Jones.—A fossil Entomostracan Bivalve, of unknown alliance, probably a Phyllopod. Valves oblong; marked with two obliquely transverse, divergent ridges, concentric lines of growth, and intermediate reticulation. Known in the Coal-measures of Britain and America.

BIBL. Jones, *Mon. Foss. Estheriæ*, 1862, p. 115; *Geol. Mag.* vii. 219.

LEANGIUM, Lk. See DIDERMA.

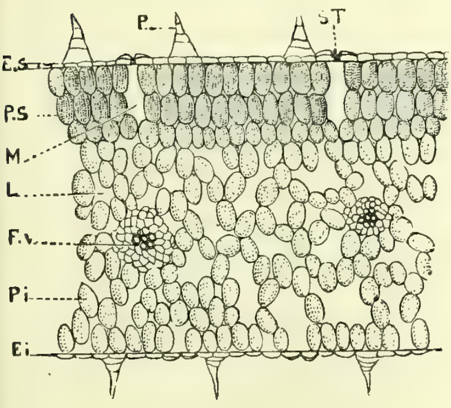
LEATHE'SIA, Gray.—A genus of Chordariaceæ (Fucoid Algæ), consisting of globose or lobulated fleshy or horny structures, growing upon rocks, either solid, or, by the solution of the internal filamentous substance, ultimately hollow. The fronds are composed of masses of dichotomous filaments radiating from a point, in the olive-coloured tufted species cohering laterally, and forming the soft, fine coat of the lobes. The *sporanges* are simple oval sacs attached at the ends of branches of the radiating filaments, between which they nestle, or multilocular, consisting of short septate filaments occurring in similar situations, which are said by Thuret to be more common; and the two kinds have not been met with together.

BIBL. Harvey, *Brit. Mar. Alg.* p. 48, pl. 10 C; *Engl. Bot.* pl. 1596; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 237, pl. 26. figs. 5–12.

LEAVES.—The microscopic structure of leaves presents a wonderful variety of con-

ditions, from the most simple up to very complex. Instances of the former are seen in the MOSSES, JUNGERMANNIEÆ, and other Flowerless plants, where merely a simple cellular plate exists. In the simpler leaves of Ferns, such as HYMENOPHYLLUM, we have a cellular plate traversed by vascular ribs. In SPHAGNUM (among the Mosses) the simple leaves have cells containing a spiral fibre. In the more complete forms we distinguish an epidermis, above and below, often differing in character on the two faces (see EPIDERMIS and STOMATA), together with the *diachyma* or intervening cellular mass, which varies in its characters in different plants, and is traversed by the fibro-vascular ribs or veins. The epidermis exhibits GLANDS, HAIRS, &c., in different conditions and forms, which cannot be enumerated again here, many of the most interesting forms being mentioned under the above heads. For observing the structure of leaves, when consisting of more than a simple cellular plate, horizontal and vertical

Fig. 391.



Vertical section of a leaf of a Melon.

E. S, superior epidermis; *P. S*, subjacent close parenchyma; *M*, infra-stomatal air-space; *L*, intercellular space; *F. v*, fibro-vascular bundle (rib or vein); *P. i*, inferior lax parenchyma; *E. i*, inferior epidermis; *P*, hairs; *ST*, stoma.

Magnified 100 diameters.

sections are required. The latter are easily made with a sharp razor in thick and firm leaves; but with delicate kinds it is necessary to split a soft cork, to place the leaf carefully between the pieces, and then to slice both together, placing the fragments in water and picking out the pieces of the leaf with a needle. Many small simple leaves make good objects by drying, soaking in turpentine, and mounting in balsam: the same may be done with petals, sepals, &c. The leaves of many water-plants, such as of *Vallisneria, Anacharis, Ceratophyllum, Hottonia*, &c., are very favourable for the observation of the rotation of the cell-sap (see ROTATION). They are of very simple cellular structure, having no epidermis, stomata, or fibro-vascular ribs.

Leaves also afford a large field for interesting study to the microscopist, in the examination of the colouring-matters and secretions in the cells, especially during the autumnal changes, of the development, &c., and moreover in the investigation of the parasitic Fungi which so frequently attack them both in the living and the decaying state.

LECAN'ORA, Ach.—A genus of the Lecanorei, consisting of numerous species, growing chiefly on rocks, stones, and earth. Thallus crustaceous, granulose, rarely radiate. Apothecia lecanorine. Paraphyses distinct. Thecæ either eight-spored or polysporous. Spores simple.

BIBL. Hook. *Brit. Flor.* ii. pt. 1; *Eng. Bot.* pl. 940; Leighton, *Lich. Flo.* 1871.

LECANO'REI.—A tribe of Placodei, a series of the Lichenacei.

BIBL. Leighton, *Lich. Fl.* 1871.

LECID'EA, Ach.—A genus of Lecideinei (Gymnocarpous Lichens), containing numerous British species. The apothecia have a border of the same colour as the disk. Growing chiefly on rocks, sometimes on bark. *L. geographica*, growing on subalpine rocks, is a remarkable species.

BIBL. Hook. *Brit. Flora*, ii. pt. 1. p. 177; *Engl. Bot.* pl. 245, &c.; Lindsay, *Journ. Mic. Sc.* v. p. 177.

LECIDEI'NEI.—A tribe of Lichenacei, containing the genera *Lecidea, Odontothrema, Schizoxylon, Agyrium.*

BIBL. Leighton, *Lich. Fl.* 1871.

LECYTH'EA, Lév. See UREDINEI.

LEECH.—Two species of the genus *Hirudo*, which belongs to the class Annulata, are used for medicinal purposes, viz. *H. medicinalis*, in which the ventral surface is greenish, with black spots; and *H. officinalis*, in which these spots are absent.

The structure of the mouth of the species of *Hirudo* is curious. The mouth is triangular (Pl. 17. fig. 25), and placed in the middle of the anterior sucker. Each of its three sides is furnished with a semicircular

jaw, of cartilaginous consistence (fig. 26, side view; fig. 27, view from above), upon the convex margin of which are placed a large number of partly calcareous teeth (fig. 26 *b*) arranged in a row. The teeth (fig. 28, *a* side view, *b* view from above) are flattened, somewhat triangular, and excavated at the base, so as to exhibit two short prongs (*d*). They are placed transversely upon the jaws, which are moved by powerful muscles, and thus produce the well-known wounds. And this cross direction of the teeth is probably the cause of the troublesome bleeding accompanying the bite of a leech, in consequence of the amount of laceration necessarily connected with it.

The species of *Hirudo* have ten minute eyes, arranged in the form of a horseshoe at the upper part of the anterior sucker.

The ova of leeches are deposited in a kind of cocoon, composed of triangular fibres, branched and interwoven so as to bear considerable resemblance to a sponge, as which one of them was formerly described.

BIBL. Brightwell, *Ann. Nat. Hist.* 1842, ix. 11; Brandt and Ratzeburg, *Mediz. Zoolog.* ii.; Johnson, *Treatise on the Medicinal Leech*, and *Further Observ., &c.*; Moquin-Tandon, *Monographie d. Hirudinées, &c.*; Savigny, *Descript. de l'Egypte*, xxi.; Audouin and Milne-Edwards, *Classif. des Annélides, &c.* in *Ann. des Sc. Nat.* 1823, 27–30 (separately printed); R. Jones, *Outl. of Animal Kingdom*, p. 192; Gervais and Van Beneden, *Zool. Med.*; Leydig, *Archiv*, 1861, p. 599; F. E. Schultze, *Zeits. wiss. Zool.* xii. 1862; Leuckart, *Die mensch. Parasit.* i.; Gratiolet, *Ann. d. Sci. Nat.* iv. 17; Rolleston, *Forms of An. Life.*

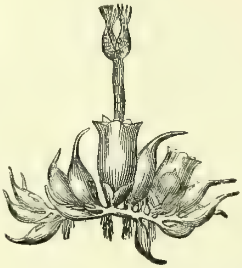
LEIBLEI'NIA, Endl.—A genus of marine plants, placed among the Ectocarpaceæ by Endlicher, and among Oscillatoriaceæ (Confervoid Algæ) by Kützing, who includes under it many of the species of *Calothrix* of other authors. Endlicher cites only *C. confervicola*, Ag., and another not British.

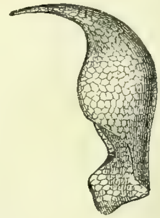
This is a minute, glaucous, tufted plant, formed of short, rigid, erect, subulate filaments, and is common, epiphytic on marine filamentous Algæ.

BIBL. Endl. *Gen. Plant.* Supp. iii. No. 69; Kütz. *Sp. Alg.* 276; Harvey, *Phyç. Brit.* p. 223, pl. 26 C.

LEJEUN'IA, Libert.—A genus of Jungermannieæ (Hepaticæ), containing several rare British species, found in subalpine districts, viz. *L. serpyllifolia, hamatifolia, minutissima*, and *calyptrifolia*. The last is one of the smallest of the British Jungermannieæ, and is remarkable for the peculiar form of its leaves, which resemble the calyptra of a moss (figs. 392, 393).

Fig. 392. Fig. 393.





Lejeunia calyptrifolia.

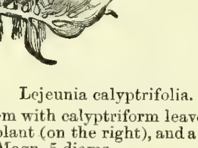
Fig. 392. Stem with calyptriform leaves, an immature plant (on the right), and a burst sporange. Magn. 5 diams.

Fig. 393. A leaf of ditto. Magn. 25 diams.

BIBL. Hook. *Brit. Jung.* pls. 42, 43, 51, 52; *Brit. Flora*, ii. pt. 1. p. 127.

LEMANI'EÆ.—A family of Confervoideæ. Olive-coloured freshwater Algæ, filamentous, inarticulate, of cartilagineo-coriaceous substance, and compound cellular texture. The *fronds* branched, hollow, bearing within at irregular distances whorls of wart-like bodies consisting of tufted, simple or branched, necklace-shaped filaments (fig. 394), arising from the inner wall of the tubular frond, and finally breaking up into elliptical spores. British genus:

Fig. 394.



Lemania torulosa.

Section of frond, showing the tufts of fertile filaments. Magn. 50 diams.

Lemania. Character the same as of the family. Two species have been found in Britain, *L. torulosa*, Ag. and *L. fluviatilis*. They always grow in clear running streams. Mr. Thwaites has made some interesting observations on the development of these plants.

BIBL. Hassall, *Brit. Freshw. Alg.* p. 68,

pl. 7; Kütz. *Phyc. generalis,* p. 261; Thwaites, *Ann. Nat. Hist.* 2 ser. i. p. 460; Wartmann, *Beitr. z. Anat. &c. d. Lemania,* St. Gallen, 1854; Rabenhorst, *Fl. Eur. Alg.* iii. p. 410. 1868.

LEMBA'DIUM, Perty. — A genus of Bursarina (Infus. Ciliata).

Char. Body oval, flat, with a broad and deep buccal fossa, the length of which is two thirds of that of the body. The fossa has on one side a row of large undulating cilia. The front of the fossa has two sets of converging cilia.

Bibl. Pritchard, *Infus.*; Claparède et Lach. *Etudes,* p. 251.

LEM'NA, L.—Duckweed. A genus of aquatic Monocotyledonous plants, remarkable for their simplicity of structure, the vegetative system being replaced by a minute leaf-like floating stem, with dependent rootlets, furnished with a well-developed sheath (*pileorhize*) at the end. The lobes of the stem bear two monœcious imperfect flowers, and also propagate by bulbils formed in the slits in the side of the lobes; the young bulbils formed in autumn sink when the parent dies, and rise again in spring. Spiral vessels occur abundantly in *L. polyrhiza*; they are sparingly present in the rest.

Bibl. Hook. and Arnott, *Brit. Flor.* p. 463; Schleiden, *Beitr. zur Botanik,* p. 229; Weddell (*Wolffia*), *Ann. des Sc. Nat.* 3 sér. pp. 12, 155.

LEMON, Essential oil of.—This is sometimes used in the microscopic examination of pollen and other structures, which are placed in it to render them more transparent, it being less disagreeable and less volatile than oil of turpentine. Glycerine may often be substituted.

LENTICELS.—Structures found upon the surface of young stems, especially of most of the Dicotyledonous shrubs and trees. They first appear on the yearling shoot as little specks, of a different colour from the rest of the epidermis. Towards the winter, or in early spring, the epidermis splits transversely over the lenticels, which become then slightly projecting papillæ, frequently divided into lips, as it were, by a median furrow. The surface of the papilla is now brown; and it is of corky character for some little distance inwards. As the branch grows, the lenticels become drawn out laterally, so as to appear like cross striæ. They are subsequently lost sight of by the bark splitting through them, as in the apple or beech, or by the bark peeling off (plane).

Microscopic examination of sections shows that they are mere hypertrophal productions from the epiphlœum, or *suberous layer* of the bark, and have no connexion with the liber or cambium. DeCandolle imagined they were root-buds, where adventitious roots might arise under favourable circumstances; but this was an error. Du Petit Thouars thought they were breathing-pores, replacing the stomata of the epidermis; but they are not pores; and many trees, such as the Conifers, Roses, *Euonymus europæus,* &c., have none.

Bibl. DeCand. *Ann. des Sc. Nat.* vii. p. 5 (1826); Von Mohl, *Vermischt. Schrift.* pp. 229, 233; Meyer, *Linnæa,* vii. p. 447; Unger, *Flora,* 1836, ii. p. 577; G. de St. Pierre, *Compt. Rend.* 1855; *Ann. Nat. Hist.* 2 ser. xvi. p. 273.

LEPADEL'LA, Bory.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes absent; foot forked.

Three species.

L. emarginata (Pl. 34. fig. 43). Carapace depressed, oval, anterior portion broad, emarginate at each end. Aquatic; length of carapace 1-570''.

Teeth of *L. ovalis,* Pl. 34. fig. 44.

Bibl. Ehr. *Infus.* p. 457.

LEPEOPHTHI'RUS, Nordm.—A genus of Crustacea, of the order Siphonostoma, and family Caligidæ.

Char. Fourth pair of legs slender, not branched, formed for walking; thorax with only two distinct joints; frontal plates destitute of sucking-disks on the under surface. Six British species, found upon various marine fishes, as the salmon, mackerel, sole, brill, turbot, &c.

L. pectoralis (Pl. 14. fig. 23).

Bibl. Baird, *Brit. Entomost.* p. 273.

LEPERDITIA, Rouault.—An extinct bivalve Entomostracan, probably Ostracodous; bean-shaped; smooth; straight on the dorsal, convex on the ventral margin; smaller in front than behind; right valve overlapping the left along the ventral edge; each valve bearing a pitted and radiate muscle-spot and an ocular tubercle. The dorsal region of the left valve is swollen in some species. Fossil only.

24 Silurian species, 4 Devonian, and 4 Carboniferous, with many varieties.

Bibl. Jones, *Ann. Nat. Hist.* 2 ser. xvii. p. 81; *M. Micr. Journ.* iv. p. 184.

LEPIDOP'TERA.—An order of Insects, consisting of butterflies and moths.

Lepidopterous insects present several points of interest to the microscopic observer; among these may be mentioned especially the proboscis or ANTLIA, the hook connecting the wings (INSECTS, p. 421), the wings themselves, and the beautiful scales covering them (SCALES OF INSECTS, TEST-OBJECTS). Their larvæ or caterpillars are favourable subjects for the examination of the internal structure,—the tracheæ with their spiracles, the fatty body, the alimentary canal, the spinning organs, the curious legs, &c.

LEPISMA, Linn.—A genus of Insects, of the order Thysanura, and family Lepismenæ.

Char. Body elongated, flattened; antennæ setaceous, with numerous very short joints; palpi four, long; abdomen terminated by three long filaments jointed near their ends.

L. saccharina (Pl. 28. fig. 18). Body silvery-grey, not spotted, covered with numerous scales; caudal filaments speckled with reddish brown; antennæ about two-thirds the length of the body.

This active little insect, which runs but does not jump, is found (in the country) upon the shelves of cupboards where sweets and other eatables are kept, in window-cracks, &c. Its habits are nocturnal. Its beautiful silvery scales are used as TEST-OBJECTS (Pl. 1. fig. 6).

There are many other species, the scales of which probably exhibit the same structure.

BIBL. Gervais, *Walckenaer's Aptères*, iii. p. 450; Lubbock, *Linn. Trans.*

LEPRALIA, Johnst.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Membraniporidæ.

Char. Polypidom adnate, crustaceous, formed of a layer of juxtaposed urceolate cells, closed in front, and spreading circularly.

The very numerous species form white, yellow, or reddish crusts upon rocks, shells, and sea-weeds. Avicularia and vibracula are present in some, but absent in others. Mouth of cells sometimes with spines.

1. *L. variolosa* (Pl. 33. fig. 17).
2. *L. unicornis.* Common.

BIBL. Johnston, *Brit. Zooph.* 300; Busk, *Mar. Polyz.*

LEPTOCLINUM, M.-Edw.—A genus of Tunicate Mollusca, of the family Botryllidæ.

Distinguished by the thin, sessile, incrusting mass of variable form, the numerous systems, the six-rayed branchial orifice, and the anal orifices opening into a common more or less branched cloaca.

Six British species: *maculosum, asperum, aureum, gelatinosum, Listerianum*, and *punctatum*, found upon the roots of *Laminaria* and other marine algæ; the two former common.

BIBL. Forbes and Hanley, *Brit. Mollusca*, i. 16; Gosse, *Mar. Zool.* ii. 32; M.-Edwards, *Mém. sur les Ascid. comp.*

LEPTOCYSTINE'MA, Archer (syn. Gonatozygon, De Bary, 1856).—A genus of Diatomaceæ. See GONATOZYGON.

BIBL. Archer, *Mic. Journ.* 1859; Rabenhorst, *Fl. Eur. Alg.* iii. p. 156.

LEPTO'GIUM.—A genus of Lichens. Family Collemacei, tribe Collemei. Thallus with a distinct cortical layer, granular; gonima moniliform; apothecia lecanorine; spores eight, multilocular, rarely simple. Species numerous. On mossy trunks, walls.

BIBL. Leighton, *Lich. Flor.* 1871.

LEPTOS'CYPHUS, Allman.—A genus of Thecaphorous Hydroida. The gonozooid of this genus is identical with the Lizzia of Forbes, from the manubrium-walls of which gemmation takes place.

One species. Stromness.

BIBL. Allman, *Ann. Nat. Hist.* 1859 & 1864; Hincks, *Brit. Hyd. Zooph.*

LEPTOSTRO'MA, Fr.—A genus of Sphæronemei (Coniomycetous Fungi), probably consisting only of the younger stylosporous states of species of HYSTERIUM or PHACIDIUM. Several species are recorded as British, some common, occurring on the stems and leaves of sedges, rushes, *Pteris*, &c., forming small round flat spots, from which the upper part of the *perithecium* splits off, leaving a little margined scar, in which are seated the stylospores.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 297; *Ann. Nat. Hist.* i. p. 257, vi. p. 365; Tulasne, *Ann. Nat. Hist.* 2 ser. viii. p. 114.

LEPTOTHRICH'EÆ.—A subfamily of the Oscillariaceæ. Filaments very fine, adnate, sheathed, indistinctly articulate; movement slow; solitary or fasciculate; for the most part in broad and diffused layers.

BIBL. Rabenhorst, *Fl. Eur. Alg.* ii. pp. 8 & 73.

LEP'TOTHRIX, Kütz.—A supposed genus of Oscillatoriaceæ. Found on damp stones, among wet plants, and in foul water;

very probably consisting of the mycelial filaments of mildew Fungi.

L. ochracea, K. (*Oscillatoria ochracea*, Grev.) is an obscure production, forming yellowish-brown flocculent masses, common in boggy pools. See DIDYMOHELIX.

L. buccalis and *L. insectorum*, Ch. Robin, probably belong to some Fungus.

BIBL. Kütz. *Sp. Alg.* 262; *Tab. Phyc.* i. pl. 61. fig. 1; Robin, *Végét. Parasit.* 2nd ed. pp. 345, 355, pl. 1. figs. 1, 2, pl. 4. figs. 1, 2; Mettenheimer, *Mus. Senkenb.* 1857. p. 139; Moggridge, *Q. J. M. S.* 1868.

LEPTOTHY'RIUM, Kütz.—A genus of Sphæronemei (Coniomycetous Fungi).

L. juglandis, Lib., *L. fragrariæ*, and *L. ribis* have been found in Britain. Probably all these are stylosporous forms of Ascomycetes.

BIBL. Fries, *Summa Veg.* pp. 371, 423; Berkeley, *Ann. Nat. Hist.* 2 ser. v. p. 371; Tulasne, *Ann. des Sc. Nat.* 4 sér. v. p. 115.

LEPTOTRICHA'CEÆ.—A family of operculated Acrocarpous Mosses, branching by innovations, or with the fertile summits several times divided. Leaves lanceolate or awl-shaped, often canaliculate-concave, with a nerve, mostly flattened or terete; cells prosenchymatous, often mingled with parenchymatous, lax or firmish, empty, not unfrequently thickened at the apex, then square. Capsule ovate or cylindrical, sometimes naked, sometimes erect, often strumulose at the base; operculum conical or subulate. Differing from Dicranaceæ in the absence of alar cells to the leaves.

British Genera.

Brachyodus, *Campylostelium*, *Seligeria*, *Angstrœmia*, *Leptotrichum*.

LEPTO'TRICHUM, Hampe.—A genus of Acrocarpous operculate Mosses, including certain *Didymodonta* and *Trichostoma* of authors.

LEPTOTRICHUM, Corda.—A genus of Sepedonei (Hyphomycetous Fungi).

LEPTUS, Lam.—See TROMBIDIUM.

L. autumnalis (*Trombidium autumnale*), the harvest-bug.

LERNEA.—A genus of Copepoda (Crustacea), interesting from being subject to a so-called retrograde metamorphosis.

BIBL. Claus. *Würzb. nat. Zeit.* ii. p. 17; Van Beneden, *Rech. Belg.*; Metzger, *Archiv für Nat.* 1868.

LERNEONE'MA, Edwards.—A genus of Crustacea, of the order Siphonostoma, and family Penelladæ.

Char. Body long, slender, narrowed anteriorly in the form of a neck, which is terminated by a swollen head, with two or three simple, curved, horn-like appendages; abdomen of inconsiderable length, simple; oviferous tubes long and slender.

Two British species: *L. spratta* (Pl. 14. fig. 24); entire length 2 inches; and *L. encrasicholi*. Both found upon the sprat.

BIBL. Baird, *Brit. Entomostraca*, p. 339.

LESKEA, Hedw.—A genus of Mosses. See HYPNUM.

LEUCINE, or caseous oxide, is a normal constituent of the lungs, spleen and pancreas, and is produced during the necrosis of tissues; for instance, in gangrene of the lung. It is one of the products of the putrefaction of cheese and muscle. Usually accompanied by tyrosine, it crystallizes in minute spheres, which frequently unite and shoot into radiating clusters. Often the spheres present a yellow tinge and a concentric lamination. The alkaline pancreatic juice transforms albumen into leucine and tyrosine. It also occurs in Crustacea, Arachnida, and Insecta.

BIBL. Miller, *Organ. Chem.*; Virchow, *Archiv*, viii. p. 337; Frey, *Das Mik.* 1865, p. 265; Rindfleisch, *Path. Hist.* p. 17, 1872. *Syd. Soc.*; Carl Voit, *Köll. & Sieb. Zeit. für wiss.* ii. 1868.

LEUCOBRYA'CEÆ.—A family of operculate Mosses arranged among the Acrocarpi, but exhibiting also lateral fruit-stalks. The leaves whitish, very fragile, composed of two kinds of cells: 1, parenchymatous, columnar, thick, empty cells, connected in several layers, perforated; 2, intercellular duct-like cells, interposed in a single curved row between those cells, 3–4 angled, filled with chlorophyll-granules. 1–2 ductose cells, situated in the middle of the leaf, prolonged out from the curved row. Peduncle rigid, very hygrometric, purple. Capsule olivaceous, brown, or at length purple. Peristome coloured in a similar manner, firm. There is only one British genus.

LEUCO'BRYUM.—Calyptra dimidiate, hood-shaped, exceeding the capsule, straw-coloured. Capsule unequal, often strumose, plaited in drying, often lateral by innovation, terminal or distinctly lateral. Teeth of the peristome sixteen, bifid, dicranoid, densely trabeculate, purple. Intercellular duct-like cells square; one situated in the middle of the leaf, mostly triangular. Leaves without nerves. Inflorescence monœcious or diœcious.

1. *Leucobryum vulgare*, Hampe = *Dicranum glaucum*, Hedw.

The foliage of this plant is remarkable for its pale colour, like that of the genus *Sphagnum*; and the peculiar structure of the cellular tissue renders it interesting.

Bibl. Mohl, *Vermischt. Schrift.* p. 310.

LEU'COCYTES.—See Inflammation (white corpuscles).

LEU'CODON, Schwægr.—A genus of Mosses. See Neckera.

LEU'COPHRYS, Clap. et Lachmann (amended).—A genus of the family Bursarina (Ciliated Infusoria).

Char. No sheath, as in *Stentor*, during part of the life-cycle; anus at the posterior extremity; no watch-glass organ; no rows of cilia in the interior of the buccal fossa; body truncated in front obliquely; buccal cirri surrounding the truncation.

Ehrenberg describes eight species; they are found in salt and fresh water, both sweet and putrescent.

1. *L. patula* (Pl. 24. fig. 38, *a* dorsal, *b* ventral surface). Body ovato-campanulate, hyaline or white, turgid; mouth large, patulous. Aquatic and marine. Length 1-288 to 1-96''. The alimentary canal, with the sacculi, according to Ehrenberg's view, is represented in fig. 38 *a*.

2. *L. spathula* (*Spathidium hyalinum*, D.) (Pl. 24. figs. 75, 76). Body lanceolate, compressed, whitish, membranous, obliquely truncated and dilated in front. Aquatic. Length 1-144''. Dujardin denies the existence of the anterior row of cilia (omitted in the figures). A very doubtful form.

Pl. 24. fig. 37 represents *L. striata*, D., which is one of the Opalina.

Bibl. Ehrenb. *Infus.* p. 311; Duj. *Infus.* p. 458; Stein, *Infus.* p. 184; Clap. et Lach. *Etudes*, 1868.

LIBELLU'LIDÆ.—A family of Insects, of the order Neuroptera. It contains several common but beautiful insects, some of which are popularly known as dragon-flies and horse-stingers, although they are harmless except to other insects. The great interest connected with them relates to the structure of the larvæ and pupæ, which live in water and are furnished with branchiæ, either internal or external, and situated at the end of the body. External branchiæ are seen in *Agrion* (Pl. 28. fig. 17). They consist of three membranous plates (Pl. 28. fig. 2 *g*), traversed by innumerable tracheæ. In *Æschna*, *Libellula*, and *Calopteryx* the branchiæ are internal and situated within the rectum (Pl. 28. fig. 20, rectum of *Æschna*). In this last genus the branchiæ are in the form of plates, which are numerous, semicircular, longitudinal, imbricated, and arranged alternately in six regular and symmetrical columns. The laminæ consist of a network of fine tracheæ, communicating with those of the body and situated beneath the mucous membrane.

The end of the abdomen is furnished with five movable valvular pieces (Pl. 28. fig. 29), three of which are larger than the others, and the uppermost of which is notched at the end. These pieces, by their contraction, expel the water from the rectum; it is renewed; and the expulsive force effects the locomotion as well as the respiration of the insect. The labium of *Æschna* also possesses a remarkable structure, forming an elongated, somewhat spatulate, mask-like appendage, which completely closes the mouth when unemployed (Pl. 41. fig. 16). In the other genera the structure is very similar. In *Libellula* six biserial rectal columns are also present; but there are no papillæ on them, and the caudal appendage is pointed and not notched (Pl. 28. fig. 22). In *Calopteryx* the rectal branchiæ are more simple, consisting of three plates attached only by the end, and resembling in structure the external plates of *Agrion*; the ocelli are distinct; and the external caudal aperture consists of three channelled and keeled pieces. The spiracles of these larvæ and pupæ are more or less concealed in the interspace between the proto- and mesothorax; they are transverse, bilabiate, and furnished with a musculo-membranous valve.

Bibl. Dufour, *Ann. d. Sc. Nat.* 1852, xvii. p. 65; Westwood, *Introd.*; Packard, *Amer. Natur.* v. 1871; Oustalet, *Ann. d. Sc. Nat.* xii.; Selys-Longchamps, *Monogr. d. Libell. d'Europe.*

LI'BER.—The term liber-cells or liber-fibres is applied to the very long forms of prosenchymatous cells, occurring isolated or in bundles at the outside of the cambium layer of Dicotyledons, and often in the pith and the ribs of the leaves; to the cells of similar form and character occurring in the outer part of the fibro-vascular bundles of Monocotyledons, and in the branches of those containing no spiral structures; also to the fibrous cells of the same kind found in the husks of many fruits, as the cocoa-nut. No exact line of demarcation can be drawn between liber-cells and wood-cells, since

the shorter of the former pass into the latter. As a rule they are much thickened by secondary deposits (Pl. 38. fig. 27); but those deposits are tougher than the wood-cells, and while they have *pores* these are never bordered with a rim. Liber-cells are not unfrequently found branched (Rhizophoraceæ, *Gnetum*); and some of the branched forms are supposed to originate by the confluence of originally distinct cells, after the manner of milk-vessels.

The layers of thickening on the walls of liber-cells frequently exhibit a spiral striation, especially after treatment with acids (Pl. 21. figs. 2, 3, 25). Von Mohl has pointed out the peculiar characters of certain structures associated with liber in the bark of Dicotyledons and in the vascular bundles of Monocotyledons. These are the Vasa propria, and are described under Vascular Bundles.

The importance of liber as a material for textile fabrics has been spoken of under Fibrous Structures, and examples cited; figures of various kinds of liber-fibre are given in Plate 21.

In Dicotyledonous stems the liber-fibres are usually placed in large bundles opposite to the fibro-vascular bundles of the wood, as in *Urtica, Viscum, Clematis, Quercus*, &c.; sometimes in small irregular groups, as in *Vinca* and *Linum*; in other cases they stand in single rows, alternating with parenchyma or *vasa propria* (*Cupressineæ* and *Taxineæ*), while in many plants they are irregularly scattered, as in *Rhizophora, Cinchona, Nerium*, &c. Isolated liber-cells occur in the pith of young shoots, and may be readily seen in the long woody radicles developed from the seeds of the Rhizophoreæ (Pl. 39. fig. 31); and in the bark and pericarp of *Gnetum*, isolated branched liber-fibres occur scattered throughout the whole mass.

In many Dicotyledons the thick-walled liber-cells are formed only in the first year, the subsequent formation in this region consisting of new layers of *vasa propria* and parenchymatous cells (*Betula alba* and *Fagus sylvatica*). In *Viburnum Lantana* the thick-walled liber is entirely wanting.

In the Monocotyledons they occur associated with short wood-cells in the fibro-vascular bundles; but they form alone the *fibrous bundles* often intermixed with and prolonged from the ends of these, occurring especially in the outer part of the stem of herbaceous Monocotyledons, such as Lilies and Grasses, and in the fleshy cortical layer of rhizomes, as in *Sparganium*, &c.

In both families they occur with the spiral vessels and wood-cells in the ribs or veins of leaves (as in *Phormium tenax*), bracts, spathes of Palms, &c.

Liber-cells are generally drawn out very gradually to a point at each end; sometimes they are very long; Schleiden states he has seen them 5″ or 6″. Sometimes they exhibit expansions at particular points, as in the Apocynaceæ. The branched forms in Rhizophoreæ, *Gnetum*, &c. are usually much shorter than the simple fibres, and their form is often very irregular (Pl. 39. fig. 31). The diameter varies a great deal in some plants; and we should scarcely venture to say that the microscopic appearance of a liber-fibre would suffice for the determination of the material of any (vegetable) textile fabric, beyond the distinction of *cotton* (or vegetable *hair*) from *linen* or other *liber*; but reagents affect them differently. The appearance presented by many kinds of fibre under the microscope, in the state in which they occur in commerce and after treatment with acids, is shown in Pl. 21. figs. 2–7, 25 & 26. The figures are taken from very characteristic examples; but many modifications occur in subordinate quantity. Flax (*Linum usitatissimum*) (fig. 2) has the walls much thickened, with distinct pores; it exhibits a very oblique close striation after boiling with nitric acid. Jute, the liber of *Corchorus capsularis*, has thinner walls, with constrictions at intervals and blunter ends (fig. 3); no spiral streaks come out here on boiling with nitric acid. The fibre from the Cocoa-nut husk occurs in bundles (fig. 4); when isolated or boiled with acid, the walls are found thin, with wide, open, spiral streaks (slits in the secondary layers); the ends are blunt (fig. 5 *a*, *b*). The fibre of hemp (*Cannabis sativa*) somewhat resembles flax, but is coarser and becomes swollen up and brittle, readily breaking across, when boiled with nitric acid (fig. 6); no spiral streaks. The liber-fibres from the bundles of *Musa textilis* (fig. 7) are fine and tough, and not much altered by boiling. Those of *Bœhmeria nivea* (fig. 25) are coarse, rough on the outside; they swell up and exhibit marked spiral slits when boiled with acid, and also distinct lamination of the thick wall (fig. 25 *c*). *Bœhmeria Puya* (fig. 26) closely resembles the former; but the spiral striation is not very evident, and the wall splits readily in the

longitudinal direction (fig. 26 *c*). The spiral striation is well seen in fig. 30 of Pl. 39, which represents the end of a liber-fibre from *Vinca minor* after boiling with nitric acid.

The *liber-bundles* of bark are sometimes set free as loose stringy fibres by the decay of the outer parts of the bark, as in the vine, *Clematis*, &c. In some plants they take a wavy course, anastomosing laterally so as to form connected reticulated sheets over the cambium: in the Lime (*Tilia*) these sheets may be detached by maceration, and they form *bast*, the material used for matting, &c. In the THYMELACEÆ (lace-bark trees) the annual layers of liber can be detached from each other, and form sheets of fibrous tissue, sometimes firm and tough, sometimes almost as delicate as muslin.

BIBL. Mohl, *Veg. Cell*, *Bot. Zeit.* xiii. p. 873; Schacht, *Die Pflanzenzelle*, p. 208; *Ann. d. Sc. Nat.* 4 sér. viii. p. 164; Henfrey, *Elem. Course* (Masters).

See also under LATICIFEROUS TISSUE.

LICEA, Schrad.—A genus of Myxogastres (Gasteromycetous Fungi), growing on damp rotten wood, in garden frames, &c., with the peridia of elongate form, grouped together, of only one layer, and containing few or no filaments among the spores. Four species are described as British, of which *L. fragiformis*, Nees, is not uncommon on wet very rotten wood, moss, &c.; the groups of peridia just before maturity somewhat resembling a strawberry; afterwards brownish.

BIBL. Berk. *Brit. Fl.* ii. pt. 2. p. 321; *Ann. Nat. Hist.* 2 ser. v. p. 367; Greville, *Sc. Crypt. Fl.* pl. 308; Fries, *Syst. Mycol.* iii. p. 195; *Summa Veg.* p. 458.

LICHENS.—A class of Thallophytes or cellular plants standing between the Algæ and the Fungi, exhibiting in the various genera relations sometimes approaching very closely to the one, sometimes to the other of these two classes. The parasitic Lichens, such as ABROTHALLUS, being destitute of a free thallus and of green gonidia, are undistinguishable from Fungi by any definite character.

The Lichens are almost universally either dry incrusting bodies, growing upon bark of trees, stones, earth, &c., as a pulverulent, or rough and horny, or laminated and mostly wrinkled and curled crust; or as horny or leathery, foliaceous or shrubby, ragged or bristling patches, seldom rising much from the surface which they overgrow; of grey, greyish green, brown, yellowish, or even reddish colour, and with a dead, pulverulent, and opaque surface. Some, however, are parasitic on other Lichens (*Abrothallus*), or upon living leaves (*Strigula*). The fructi-

Fig. 395.

Sphærophoron coralloides.
Thallus with apothecia.
Nat. size.

fications, in which the spores are produced, are either little nodules (fig. 395), often

Fig. 397.

Fig. 396.

Fig. 398.

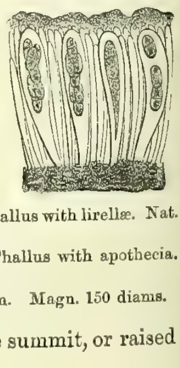


Fig. 396. Opegrapha atra. Thallus with lirellæ. Nat. size.

Fig. 397. Borrera ciliaris. Thallus with apothecia. Nat. size.

Fig. 398. Section of thalamium. Magn. 150 diams.

with a minute pore at the summit, or raised

lines (fig. 396), or round, shield-shaped or cup-shaped bodies (fig. 397) scattered over the surface of their fronds, or borne at the summits of the branches of the shrubby kinds. In some species the 'fruits' are the only parts visible to the naked eye, the thallus being composed of very small collections of microscopic elements, more or less concealed in the matrix on which the plants grow.

In the simplest kind of Lichens, the thallus ("*hypha*") consists of microscopic branched filaments penetrating among the superficial layers of the cells of the bark or epidermis upon which the plants grow. These filaments usually present globular cells here and there growing out from them, filled with green matter, which globular cells are capable of reproducing the plant when detached; they are called *gonidia*, and are regarded as analogous to the *buds* of the Flowering plants and the cellular *gemmæ* of the higher Cryptogams. In the simple forms here alluded to, the gonidia are not sufficiently numerous to give a coloured tinge to the structure as seen by the naked eye; in some even the filaments make no show, while in others they form whitish patches (*Opegrapha*, *Verrucaria*). In the forms rather more developed we find a layer of globular epidermal cells, with whitish contents, closely coherent together, constituting a 'cortical layer' covering the upper surface, to which the filamentous structure (or *hypothallus*) then forms the 'medullary layer.' The crustaceous kinds overgrowing stones have this filamentous medullary layer very solid; and in some of them its lowest filaments are seen growing out all round the borders, in the direction in which the plant is extending, the upper filaments with the gonidia and the cortical layer by degrees overgrowing these lowest filaments, which in the meantime have extended further out. Some of the crustaceous Lichens grow out in more or less regular lobes at their borders, and thence lead to the pseudo-foliaceous forms, of which the common *Parmelia parietina*, the yellow Lichen so abundant on walls, and *Borrera ciliaris*, common on branches of trees (fig. 397), may serve as examples. The thin paper-like thallus of the former exhibits *four* distinct regions (Pl. 29. fig. 2):—1. on the upper face a layer of thick cells, firmly connected together, coloured yellow at the surface (*upper cortical* or *epidermal layer*); 2. a layer like the preceding, but white, forming the inferior surface of the thallus (*lower cortical* or *epidermal layer*); 3. beneath the upper cortical layer lie the *gonidia*; and 4, under these lie the *medullary* filaments forming the central substance, at the upper part of which lie the gonidia arising from these filaments. These are interlaced and imprison air between them. From the lower face arise laminæ or fibrous processes, like roots, serving as cramps by which the plant attaches itself to the surface on which it grows. In *Peltigera canina* there is no inferior epidermal or cortical layer, the filamentous medullary structure forming the irregular veined surface, prolonged here and there into pseudo-radical processes. In *Endocarpon* and other fronds of solid texture, the medullary layer is formed of slender linear cells, closely packed, with few air-passages. The species of *Cladonia* exhibit a structure of the thallus intermediate between that of the foliaceous kind just referred to and the shrubby sort. In the foliaceous expansion resting on the ground, of *C. pyxidata*, for example, we detect the upper epidermis, next the gonidial layer, which again rests on the closely-felted filamentous medullary substance. In the branches of *C. rangiferina*, as in a great number of its congeners, there is no well-defined epidermis. The branches are tubes, vacant in the centre, formed of a cartilaginous structure, in which only two zones can be distinguished, the inner and more solid of which is composed of almost simple, parallel, solid filaments intimately glued together by mucous substance; the outer zone is formed of a felted mass of filaments, likewise solid, but branched and divaricated. The solidity of these filaments arises from the obliteration of the cell-cavity by secondary layers on its walls, giving the filaments a horny texture. In the outer loose layer are found scattered groups of gonidia. In *Stereocaulon denudatum* the branches are solid and formed exclusively of parallel filaments, as is the case also with those of *Ramalina scopulorum*. In *Evernia vulpina* there is a solid axis formed of parallel filaments enclosed in a layer of interlaced fibres, between which and the horny coat, which is either solid or very obscurely cellular, gonidia are here and there to be observed.

Masses of gonidia (called granula gonima) in orbicular concretions occur on the thallus, and are termed *cephalodia*.

In many Lichens, when exposed to excess of moisture, the proper fructification is not

developed, and the gonidial structure is produced so abundantly as to burst through the superficial cortical layer and become naked, giving a mealy appearance to the thallus. Lichens reproduced by gonidia commonly grow at first into a pulverulent stratum by the multiplication of the cells, giving rise to the forms which were at one time thought distinct genera, such as LEPRARIA.

The gonidia, whether as free cellules, as attached to the medullary filaments, as massive collections, or in patches remote from the thallus, yield zoospores. Other gonidia, which do not yield zoospores, are clusters of spherical motionless granules or granula gonima.

The fronds of *Collema* are remarkable for their gelatinous texture, and approach the Nostochaceæ (Algæ) in the simplicity of their structure. The thallus of *C. cheileum* consists of branched and colourless filaments or tubes, imbedded in an abundance of mucilage; in *C. jacobeæfolium*, there exist in addition very numerous green granules, almost all arranged in long beaded lines (Pl. 29. fig. 13), some being larger than others, the whole mixed with the continuous filaments and imbedded in mucus. Both species have long, whitish, branched, filamentous pseudo-radical processes.

Putting aside the *gonidia* or gemmule-cells of the thallus, the reproductive organs of the Lichens are of three kinds:—1, the *apothecia*, which, according to their forms, receive different names, and are all characterized by producing the sacs (*thecæ*) containing spores; 2, the *spermogonia*, which some regard as antheridia, and which produce extremely minute cylindrical bodies (*spermatia*) growing at the ends of short pedicels, from which they are ultimately detached, like the spores of many Fungi; and, 3, *pycnidia*, in which are developed *stylospores* like those of Fungi.

The commonest form of the *apothecia* is that of sessile or stalked disks or cushions, flat, convex, or hollowed into a cup (fig. 397); in other cases they are linear: these open forms characterize the division called Gymnocarpous Lichens, while in the Angiocarpous genera the apothecia or rather perithecia are closed globular receptacles or conceptacles, analogous to those of the *Sphæriæ* among the Fungi, and opening at the summit to discharge the spores (fig. 395). The *apothecium* may be composed of two parts—the *thalamium* or *hymenium*, and the *excipulum*. The excipulum, when present, may be in the Gymnocarpi a cup-like envelope derived from the thallus, and of the same colour (*thalline*), or may differ in colour and texture, in which case it is termed "*proper*." In the Angiocarpous forms it may entirely or only partly surround the thalamium and thecæ, and then forms the *perithecium*. The *thalamium* is represented by the body of the apothecium, open or closed; and the layer of its cells immediately lining the bottom of the cup, shield, or conceptacle is sometimes called the *hypothecium*, which bears the *thecæ* and the *paraphyses* (fig. 398); the latter are filiform or clavate cells (Pl. 29. figs. 6 & 12), probably abortive thecæ, among which they are intermingled; both these and the thecæ stand perpendicularly upon the hypothecium. The *thecæ* (Pl. 29. figs. 6 & 12) are usually ovoid or elongated cells with thick walls, containing the spores; the thecæ are shorter than the paraphyses surrounding them; and the whole are usually glued firmly together by their contiguous lateral surfaces.

The *spores* consist of two layers, an epispore and an endospore; the former are tinged blue with tincture of iodine, and present many points of difference in different genera and species. In *Verrucaria muralis* they are ellipsoid, colourless, perfectly smooth and semi-transparent, containing granular matter; while in *V. epidermidis* and *atomaria* they are bilocular bodies, representing a pair of obovoid cells adherent by their thick ends. In their earlier stages of development they appear solid; subsequently four nuclei or oily globules are seen in them, each occupying a spherical cavity. The membrane of the spore then becomes thinner, and finally its two cavities coalesce into one. When ripe, these spores are about 1-1500″ in length and about 1-4000″ broad. There are eight in each theca, and they are separately enveloped in a mucilaginous coat. The spores are largest in the Angiocarpous genus *Pertusaria*. Those of *P. communis* are visible to the naked eye; and observed in water soon after emission from the thecæ, they are not less than 7-1000″ to 8-1000″ long by 5-1000″ broad. Their simple cavity is filled with granular semi-transparent matter, usually with oil-globules of various sizes. The epispore is very broad, transparent, and formed of several lamellæ; these also are coated with mucus. The genus *Parmelia* offers both

simple and bilocular spores. Of the former, *P. parietina* gives an example, though in some cases a transverse partition is formed, and this is the normal state in *P. stellaris* (Pl. 29. figs. 6 & 7). In *Peltigera* (Pl. 29. fig. 11) the spores are elongated. In *Collema* and other genera the spores are divided into four chambers by three transverse septa.

In several species of *Lecanora, Lecidea, Urceolaria,* and a great number of Angiocarpous Lichens, a more complex form of spore exists, longitudinal together with transverse septa dividing the cavity into several series of chambers. Those of *Urceolaria* (Pl. 29. fig. 17) have eight or ten compartments; those of *Lecanactis urceolata, Thelotrema lepadina, Umbilicaria pustulata* (Pl. 29. fig. 18), and other Lichens (called muriform spores) have a much larger number of little cavities, each containing a distinct *nucleus.*

The emission of the ripe spores takes place in the same way as in the *Pezizæ, Helvellæ, Sphæriæ,* and many other Fungi of the same kind. If a portion of the thallus, moistened, is placed in a common phial, with the apothecia turned toward one side, in about eight or ten hours the surface of the glass opposite each apothecium will be found covered with patches of spores, easily perceptible by their colour, these having been projected from the apothecia with force. If placed on a moist surface, and a slip of glass laid over them, the latter will become covered with them in the same way; and Tulasne states that they are projected to a distance of more than half an inch from the theciferous layer, the spores being emitted continuously for a long time. The experiment may be tried either in winter or summer, and has been made with success on several common species of *Parmelia, Lecanora, Peltigera, Collema, Borrera ciliaris, Verrucaria muralis, Endocarpon hepaticum, Pertusaria, Urceolaria, Opegrapha,* &c.

The expulsion of the spores of the Lichens takes place slowly, while that of some Ascomycetous Fungi is sudden, which may be accounted for by the different consistence of the surrounding structures.

Eight is generally set down as the normal number of spores in each theca; but this is not universal here any more than in the Ascomycetous Fungi; some species of *Endocarpon, Parmelia,* &c., have polysporous thecæ containing a considerable number, while there are often less than eight.

Spermogonia. In addition to the preceding, the Lichens exhibit another form of reproductive organs, which are liable to be confounded with *Sphæronemei* and other Fungi growing on the Lichens, or with parasitical Lichens in similar positions. They appear as black or brown points, usually near the margins of the thallus (Pl. 29. fig. 1), and have been found in *Borrera, Parmelia, Sticta, Cladonia, Collema, Opegrapha, Sphærophoron, Lichina, Endocarpon,* &c., and seem to be universal.

The spermogonia are hollow pustules, lined with filaments producing extremely minute bacilliform corpuscles, the *spermatia.* In most cases they are immersed in the substance of the thallus (Pl. 29. figs. 2 & 13), and are perceptible externally only by a little projection, if at all; in rare cases they are free and borne above the thallus (some *Cladoniæ, Cetrariæ, Gyalectæ,* &c.). The ordinary form of the spermogonia is globular, ellipsoidal or irregularly oblong, and sometimes with a sinuous outline. They have either a simple undivided cavity (Pl. 29. figs. 13, 16), or are multilocular, divided in different ways into a variable number either of separate chambers or narrow cavities, all communicating with a common orifice, which is the *ostiole* or *pore* of the apparatus. This structure bears a close relation to that usual in the related Fungi (Coniomycetous forms, *Cytispora, Septoria,* &c.), and bears testimony to the close connexion between the Lichens and Fungi. The form and dimensions of the *spermatophores,* or peduncles of the *spermatia,* vary much. The simplest are short slender stalks, simple or branched, or they are articulated branches composed of a great number of cylindroid or globular cells (Pl. 29. figs. 3 & 14), or the branches are reduced to two or three elongated cells. The *spermatia* are terminal on the spermatophores, and consist of exceedingly minute bodies, ordinarily linear, very thin, short or longish, straight or curved (Pl. 29. figs. 3, 10, 15, 16), without appendages and motionless, and lie in a mucilage of extreme transparency. The *spermatophores* and their *spermatia* usually fill up the cavity of the spermogonia when just mature; afterwards, when the development is complete and the spermatia discharged, the spermogonia are found empty and discoloured.

The minute bodies, called *spermatia,* are

regarded by most of those who have observed them as analogues of the spermatozoids produced in the antheridia of the higher Cryptogams. Itzigsohn imagined that he saw a spontaneous motion of them when lying in water beneath the microscope; but this appears to have been an error, and the only movement really existing has been regarded, probably most correctly, as merely molecular—that universal in extremely minute bodies, living or dead, lying in a fluid.

Pycnidia and Stylospores. This last name is given to certain rare organs discovered by Tulasne in *Abrothallus* and *Scutula*, consisting of isolated spores borne upon shortish simple stalks. They are produced in conceptacles, to which is applied the name of *pycnidia.* They are closely analogous to the structures of the same name found in some Fungi (see STYLOSPORES).

Some microscopic parasitic plants, which affect the thallus and apothecia of Lichens, are partly referable to the Lichens and partly to the Fungi; and Lauder Lindsay says that they partake of the characters of both. Sometimes the parasite occurs in the form of asciferous or sporidiferous apothecia or perithecia, with or without spermogonia or pycnidia; or the latter secondary or complementary forms of reproductive organs occur alone.

It is impossible to draw any sharp boundary line between the lower Lichens and the lower Fungi; and the old diagnostic of the blue reaction with iodine has long since proved fallacious. The micro-Lichens illustrate this assertion. They are athalline forms for the most part, whose apothecia alone represent the plant. Minute in size, frequently obscure and difficult of observation, they are frequently parasitic. Moreover Berkeley, *Int. to Crypt. Bot.* p. 341, has shown that *Emericella*, a genus of Fungi, has a structure in the stem exactly like that of *Glœocapsa.* The same author has figured the hypha of *Parmelia parietina* producing gonidia within decomposed cells of White Spruce.

Certain chemical reagents are useful in the study of Lichens. Thus the iodine solution will tinge the mature spores or the gelatina hymenea of some Lichens blue, or red without a preparatory blue tinge. Hydrate-of-potash solution produces in the thallus of some Lichens a persistent yellow colour, and in that of others it changes to a red; or if no reaction takes place, chloride of lime and water being applied, produce red or yellow colours as the case may be.

Relation to Algæ. Free gonidia are the same as the unicellular Alga *Cystococcus*, Näg.; so that this is not a separate form but a distinct phase of development in a Lichen. The gonimic cellules of *Peltigera* and *Collema* when separated from their thallus, the first produced the so-called Alga *Protococcus*, and the latter organisms similar to *Nostoc.* Moreover it is impossible to distinguish gonidia from certain stages of the development of Mosses.

It has been suggested that either such Lichens as *Collema* and *Ephebe* are the perfectly developed states of a plant whose imperfectly developed forms have hitherto stood among the Algæ as the Nostocaceæ and Chroococcaceæ. Or these last-mentioned plants are typical Algæ; they assume the form of *Collema* and *Ephebe* through certain parasitic Ascomycetes penetrating into them and spreading their mycelium into the continuously growing thallus. Schwendener states that all these growths (Lichens) are not simple plants or individuals, but rather colonies which consist of multitudes of individuals, of which one alone plays the master, while the rest, in perpetual captivity, prepare his food. The master is the Ascomycete, and the slaves are green Algæ. He asserts that Nostocaceous plants which live in moist or wet habitats, not those which are purely aquatic, form the foundation or basis of Collemaceæ (Archer, *Q. Mic. Jn.* xii. p. 367). But this opinion that Lichens are parasitic on Algæ is open to much doubt.

The Lichens are ordinarily divided into two orders, according to the structure of their apothecia, which are either closed at first, bursting subsequently by a pore or an irregular orifice, containing the *thecæ* in a *nucleus* in the interior; or they are open from an early period, and bear the *thecæ* on the upper (mostly concave) surface (*disk*).

GYMNOCARPI is the title of the order of Lichens characterized by bearing open apothecia, in the form of shields (*scutella*), cups (*scyphi*), rings (*annuli*), or irregular cracks or lines (*lirellæ*) with raised borders, &c. These apothecia are either sessile on a flat spreading thallus, or raised on more or less developed stalk-like processes of the branched and shrubby forms. The upper, open, often concave surface of the apothecia,

called the *disk*, is clothed with thecæ and paraphyses.

ANGIOCARPI, the second of the orders into which Lichens are divided, are characterized by the closed apothecia, where the thecæ and paraphyses are collected into a *nucleus* enclosed in a case called the *perithecium*, bursting at the summit by a pore or an irregular opening to discharge the spores. The apothecium is more or less globular, and either imbedded in the thallus or distinct and raised above it. The perithecium either entirely encloses the nucleus or is hemispherical (*dimidiate*), clothing the upper projecting portion.

BIBL. Tulasne, *Mém. p. s. à l'hist. organog. des Lichens, Ann. d. Sc. Nat.* 3 sér. xvii.; *On Reprod. of Lichens and Fungi, Ann. N. H.* 2nd ser. vol. viii. p. 114; Körber, *Grundriss der Kryptogam.*, Bresl. 1848; *Die Entw. der Flechten*, 1828; Montagne, *Aperçu morphol. d. Lichens, Dict. univ. d'hist. nat.* Paris, 1846; Bayrhoffer, *Einig. üb. Lichen.*, Berne, 1851; Itzigsohn, *Botan. Zeit.* viii. 393, 913, ix. 153; Flotow, in the *Flora* and *Botanische Zeitung*; Leighton, *British Angiocarpous Lichens, Ray Soc.* 1851; Lindsay, *Pop. Hist. of Lichens*; Speerschneider, *Bot. Zeit.* xiii. 345; Braxton Hicks, *Linn. Trans.*; *Qu. Mic. Jn.* 1860 & 1861; Lauder Lindsay, *Qu. Mic. Jn.* v., viii., ix., xi.; Famnitzin and Boranetzky, *Ann. d. Sci. Nat.* viii.; Leighton, *Brit. Lich. Flora*; Henfrey, *Elem. Course* (Masters). (Want of space will not permit of Leighton's classification being given; but it is frequently followed by us.) *Not. Lichen.* Leighton, *Ann. Nat. Hist. passim*; Schwendener, *in Nägeli's Beitr. zu wiss. B.* iv. p. 195, and *Algentypen der Flecht. Basel*, 1869; Bory, *in Hofmeist. Hand. d. phys. Bot.* Bd. ii. p. 291; Archer, *Qu. Mic. Jn.* xii. p. 367.

LICHI'NA, Ag.—A genus of Lichineæ (Lichens), fam. Collemacei, allied to COLLEMA and EPHEBE in many respects, formerly included among the Algæ on account of their growing on the sea-shore (near high-water mark), but having the thallus of a lichen and bearing true *apothecia* and *spermogonia*. The globose apothecia occur at the ends of the branches of the thallus; in *L. pygmæa* the spermogonia occur underneath the apothecia, in *L. confinis* at the apices of the branches and often on the apothecia. The spores, 8, appear generally to adhere to the walls of the thecæ, which break up. Spermatia oblong.

BIBL. Harvey, *Brit. Alg.* 1 ed. p. 22; Hook. *Brit. Fl.* ii. pt. 1. p. 274; Greville, *Alg. Brit.* pl. 6; Leighton, *Brit. Lich. Flor.*

LICHIN'EÆ.—A family of Angiocarpous Lichens, of remarkable habit, the species of which were formerly regarded in their perfect and imperfect states as Algæ. The branched thallus is of gelatinous texture, very soft when wet, cartilaginous when dry, growing on wet rocks, *Lichina* being marine. The fructification consists of closed *apothecia* and *spermogonia* formed in the substance or at the ends of the branches. The Lichinei of Leighton, *op. cit.*

For the British genera *Lichina* and *Ephebe*, see those genera.

LICMO'PHORA, Ag.—A genus of Diatomaceæ.

Char. Frustules in front view cuneate, elongate, radiating in a fan-shaped manner from a branched stipes; side view (valves) convex, inflected at the larger end and furnished with transverse striæ (rows of dots). Marine.

L. radians, K. (*L. flabellata*, S.) (Pl. 13. fig. 3).

The species (one other British, Sm., five in all, Kütz.) are too doubtfully distinct to deserve description.

BIBL. Smith, *Brit. Diat.* i. 85; Kütz. *Bacill.* 123, and *Sp. Alg.* 113.

LIEBERKUEHNIA, Clap. et Lach.—A genus of Rhizopoda, order Gromida.

Char. Pseudopodia arising from definite spots, and surrounded at first and for greater or less lengths by an expansion of the surface; the pseudopodia are long and become reticulate. Circulation of protoplasmic tissue rapid. 1 species. From unknown fresh water at Berlin. Probably it has a nucleus and contractile vesicle.

BIBL. Clap. et Lach. *Etudes*, p. 465.

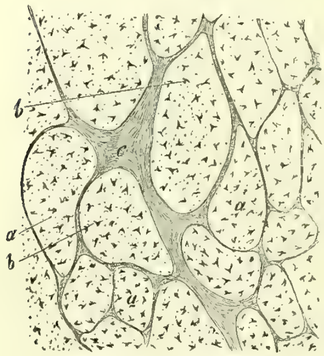
LIEBERKÜHN. INTROD., p. xix.

LIGAMENTS and TENDONS.—With the exception of the elastic ligaments, which are noticed under that head, the structure of ligaments and tendons is essentially the same. They consist of fibrillar connective tissue, with a small quantity of elastic tissue. The fibres or fibrillæ of the areolar tissue are very minute, longitudinal, parallel, closely connected, and pursue a straight or undulatory course. Their union into bundles is sometimes very indistinct, and only to be shown by drying transverse sections and afterwards treating them with alkalies. In other instances the bundles are easily recognizable, of a polygonal, rounded or elon-

gated form (fig. 400), and connected by loose interstitial areolar tissue.

One portion of the tissue of tendons exists as slender nuclear fibres, sometimes forming rows of narrow spindle-shaped cells con-

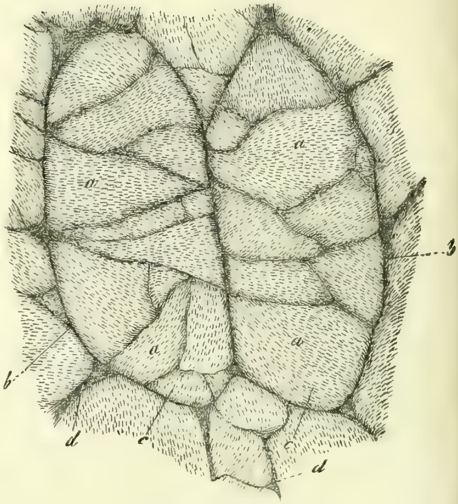
Fig. 399.



Magnified 60 diameters.

Transverse section of the tendon of the tibialis posticus; human: *a*, secondary bundles; *b*, larger nuclear fibres; *c*, interstitial areolar tissue.

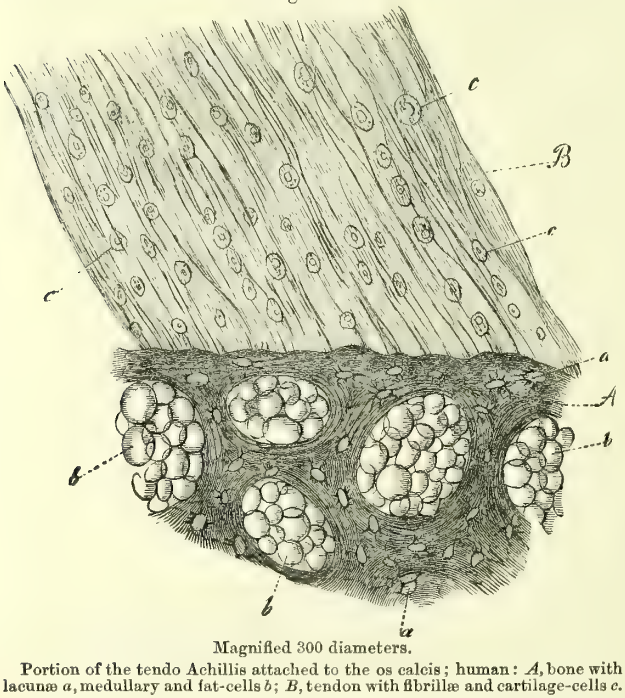
Fig. 400.



Magnified 20 diameters.

Transverse section of a tendon of a calf: *a*, secondary, *b*, tertiary bundles; *c*, nuclear fibres, obliquely divided; *d*, interstitial areolar tissue.

Fig. 401.



Magnified 300 diameters.

Portion of the tendo Achillis attached to the os calcis; human: *A*, bone with lacunæ *a*, medullary and fat-cells *b*; *B*, tendon with fibrillæ and cartilage-cells *c*.

nected by slender processes, at others uniform fibres, or isolated spindle-shaped cells. These are placed at regular distances apart, between the bundles of areolar tissue.

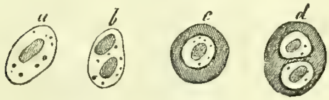
In some tendons these nucleated spindle-shaped cells are subject to some variation in shape; in others they overlap the fibrils in definite order; and as many French, German, and English histologists have examined the structures, using different methods of procedure and different reagents, a great amount of contradictory evidence has been published.

When tendons are in contact with bones, they frequently contain cartilage-cells, either isolated or arranged in rows (fig. 401 *c*); these sometimes undergo ossification.

The aponeuroses, fasciæ,

and tendinous sheaths consist of the same elements, but in various proportions and differently arranged according to their functions,—sometimes the areolar fibres being predominant, the structure agreeing with that of tendon, whilst at others the elastic tissue is greatly developed (fig. 402). Some of these tissues also contain cartilage-cells.

Fig. 403.



Magnified 350 diameters.

Cartilage-cells from the membranous ligament surrounding the popliteus muscle: *a*, cell with one nucleus; *b*, cell with two nuclei; *c*, cell containing one; *d*, two secondary cells, the contents of both of which are more consistent.

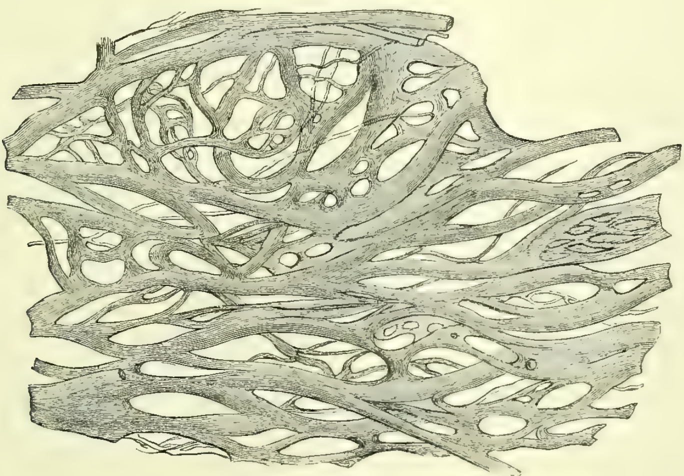
The intervertebral ligaments consist of fibro-cartilage, surrounded by osseous tissue; the centre is soft and containing concentric cartilage corpuscles (fig. 101), p. 129.

Bibl. Kölliker, *Mik. Anat.* i.; Henle, *Allgem. Anat.*; Donders, *Mulder's Physiol. Chem.* See references in J. M. Bruce, *Qu. Mic. Jn.*, 1872, p. 129.

LIGNINE.—A modified condition of cellulose is obtained from old wood-cells, and called by this name. It differs in its reactions from pure cellulose, being coloured yellow by sulphuric acid and iodine; but after boiling in nitric acid and washing, tincture of iodine and water give it a blue colour. See Secondary Deposits.

LIMBORIEÆ.—A family of Angiocarpous or closed-fruited Lichens characterized by rounded apothecia closed in by a carbonaceous special perithecium, finally bursting in various ways, containing a somewhat waxy nucleus, which grows hard.

Fig. 402.



Magnified 450 diameters.

Elastic fibres from the inner part of the fascia lata, human; densely interwoven and forming an elastic membrane.

British Genera: *Pyrenothea, Strigula.*

LIME, SALTS OF.

Carbonate of lime. This substance is well known as forming chalk, marble, &c., and as occurring in hard animal structures, as bone, shell, &c. It is not unfrequently met with in the form of granules as a component of various animal secretions, as the urine, &c. In this liquid, it sometimes, but rarely, also occurs in little spheres or disks, consisting of groups of radiating needles. This we first found to be the case in human urine (Pl. 9. fig. 8); but it was subsequently detected in that of herbivorous animals, as the cow and the horse (Pl. 9. fig. 7), in which its occurrence is common. It is also a component of otolithes, in which it exists either as granules or minute prisms, often with six sides and trilateral summits. From river- and spring-water it is usually deposited in irregular and imperfect forms (Pl. 9. fig. 6),

all of which consist of grouped needles. Sometimes it assumes the rhombohedral form, as in the shell of the oyster (Pl. 36. fig. 10) and frequently in chemical solutions. When treated with a dilute acid, after having been thoroughly washed in a watch-glass, it is dissolved with effervescence from the escape of carbonic acid gas. During the solution it first becomes more transparent, exhibiting the internal crystalline structure, and frequently a concentric or nuclear appearance, which finally disappears. When derived from animal secretions, it leaves undissolved an organic cast of the original, provided the acid be not too strong, or its action too long continued. If the number and size of the minute bodies be relatively very small in proportion to the amount of water, on adding the acid, effervescence will not occur, the water holding in solution the carbonic acid evolved. The presence of the lime may be tested in the ordinary way, by the addition of oxalate of ammonia, when the precipitate is insoluble in acetic acid, or by adding dilute sulphuric acid, when crystalline needles of the sulphate of lime (Pl. 6. fig. 16) are formed.

The spheres or disks naturally occurring in the urine, are closely imitated by those formed in urine to which chloride of calcium has been added, and which has been subsequently kept for some time.

Lactate of lime may be obtained by acting upon carbonate of lime with lactic acid. It is soluble in water and alcohol. The microscopic crystals consist of tufts of delicate radiating needles (Pl. 7. fig. 19).

Oxalate of lime. This salt exists in solution in the contents of many vegetable cells combined with a proteine compound; it is also probably a normal constituent of the human blood in small quantity, combined and dissolved as in vegetables.

In the cells of plants it is very frequently deposited in a crystalline form, constituting Raphides. From human blood it has been obtained in crystals by treating the alcoholic extract with acetic acid. It is very commonly met with in the crystalline form in various secretions of animals, as the urine, the mucus of the gall-bladder, that of the surface of the pregnant uterus, the liquid of the allantois, the contents of the Malpighian vessels, and the so-called true renal vessels of insects, cysts, &c.

Its most characteristic form is the square flattened octahedron (Pl. 9. fig. 9); but it also occurs in the form of the square prism terminated by quadrilateral pyramids, of fine needles, and in that of a flattened body with an ellipsoidal outline, frequently constricted so as to resemble a dumbbell, or variously excavated at parts of the surface (Pl. 9. figs. 11 & 12). It may be obtained artificially in most of these forms (Pl. 9. fig. 13), by dissolving artificial oxalate of lime in dilute nitric acid and evaporating; some of the forms thus obtained resemble those of carbonate of lime. When obtained by mixing oxalate of ammonia with soluble salts of lime, as chloride of calcium, &c., the crystals are generally peculiar (Pl. 9. fig. 14), although sometimes the regular octahedra are obtained.

It is insoluble in hot and cold water, acetic acid and ammonia, but is soluble in dilute mineral acids without effervescence.

Phosphate of lime. This salt is most frequently deposited from animal liquids in an amorphous or granular state. It may be obtained in the crystalline form by mixing a solution of phosphate of soda with chloride of calcium. The crystals are mostly thin rhombic plates (Pl. 6. fig. 17).

They are soluble in acetic and dilute mineral acids without effervescence, but not in potash or water. Some of the compound crystals resemble those of the ammonio-phosphate of magnesia, from which they may be distinguished by the addition of dilute sulphuric acid, which causes the formation of needles of sulphate of lime.

Sulphate of lime. Well known as forming gypsum, alabaster, selenite, &c. It rarely or never occurs in the crystalline form in animal or vegetable products. When rapidly formed in chemical testing, the crystals consist of minute needles or prisms (Pl. 6. fig. 16); when more slowly formed, these are larger and mixed with rhombic plates.

The crystals are but little soluble in water, and not in acetic or the dilute mineral acids. They are sometimes found in bottles containing spirit in which marine animals have been preserved.

Medicinal precipitated sulphur is very commonly adulterated with sulphate of lime. The microscope at once enables the crystals of the salt to be recognized.

Urate of lime. See Urates.

Artificial or molecular coalescence. Rainey brought about a slow decomposition of the salts of lime held in suspension in gum-arabic solution by the agency of subcarbonate of potash; spheroidal concretions made up of concentric layers of carbonate of lime resulted; and sometimes coalescence took place,

producing the dumbbell form. Harting, of Utrecht, using albumen, solution of gelatine, a mixture of both, blood, bile, mucus, liquor from the umbrella of *Aurelia aurita*, and the liquor from chopped up oysters, placed in these solutions salts which, by their mutual reaction, form insoluble salts of lime. His results were dumbbells, single and in aggregations, curved laminæ, and "calcospherites." These contain, when made in albumen, a substance which is no longer albumen but *calcoglobuline*. When phosphate of lime is liberated by the double decomposition of chloride of calcium and neutral phosphate of soda or ammonia, and carbonate of lime is produced at the same time in the liquid, the precipitate consists of a combination of the organic matter with the two salts. When there is an excess of phosphate of lime, calcospherites and other forms are produced, which are the starting-points for various ulterior formations, such as plates more or less curved, either homogeneous or fibrillar. The resemblance of these to the shell-structure of some of the Lamellibranchiata is very remarkable.

BIBL. Rainey, *Form. of Shell and Bone*, & *Qu. Jour. Mic. Sci.* vi. p. 23; Harting, *Qu. Mic. Jn.* xii. p. 118.

See RAPHIDES and URINARY DEPOSITS.

BIBL. That of CHEMISTRY, ANIMAL.

LIMNAC'TIS, Ktz.—A genus of Rivulariaceæ, freshwater Algæ.

Char. Filaments pseudo-ramose, subfasciculate, sheath more or less distinct. *L. parvula* is a Lincolnshire species.

BIBL. Rabenh. *Fl. Eur. Alg.* ii. p. 210.

LIMNADEL'LA, Girard.—An aquatic bivalve Phyllopodous Entomostracon, near *Estheria*.

BIBL. Girard, *Proc. Phil. Ac.* i. 184, & vii. 34; Grube, *Wieg. Arch.* 1865, 73.

LIMNA'DIA, Ad. Brongn.—An aquatic bivalved Phyllopod, with thin oval valves, enclosing an elongated body, having a short and a natatory pair of antennæ, oral apparatus, twenty-two or more pairs of branchial lamellæ, and a bifid tail.

BIBL. Ad. Brongniart, *Mém. Mus. Hist. Nat.* vi. pl. 13; Desmarest, *Crust.* 378; Milne-Edwards, *Hist. Nat. Crust.* pl. 35. f. 7; Baird, *Proc. Zool. Soc.* 1849, 86; *Annulosa*, pl. 11. f. 1; Grube, *Wiegm. Arch.* 1865, 61, pl. 8, &c.; Lereboullet, *Ann. Sc. Nat. Zool.* 5, v. p. 283, pl. 12.

LIMNE'TIS, Lovén.—An aquatic Bivalved Phyllopod, related to *Limnadia* and *Estheria*.

BIBL. Lovén, *K. V. Ak. Handl.* 1845, 203; Baird, *Proc. Zool. Soc.* 1862; Grube, *Wiegm. Arch.* 1865, 71.

LIMNIAS, Schrank.—A genus of Rotatoria, of the family Floscularizea.

Char. Eyes (when young) two, red; urceoli or sheaths single; rotatory organ with two lobes. Teeth forming a row in each jaw.

L. ceratophylli (Pl. 34. fig. 45). Urceolus at first whitish, subsequently becoming brown or blackish, smooth, or in consequence of its viscidity covered with foreign bodies. Aquatic; length 1-24 to 1-18".

BIBL. Ehr. *Infus.* p. 401.

LIMNICY'THERE, Brady.—An Ostracod, allied to *Cythere*, the antennæ having setæ instead of spines, and the valves being thin, and spinous or tubercled.

BIBL. G. S. Brady, *Tr. Linn. Soc.* xxvi. 419.

LIMNOCH'ARES, Latr.—A genus of Arachnida, of the order Acarina and family Hydrachnea.

C. aquatica (*holosericea*) (Pl. 2. fig. 27). The only species. It differs from all other water-spiders by its walking instead of swimming.

Body very soft and often spontaneously variable in form; epidermis covered with little conical granules (?); no hairs upon the body, and but few upon the legs; eyes attached to a lanceolate scaly piece (*d*), and surrounded by hairs; rostrum partly concealed beneath the skin, the anterior exserted half (*b*) cylindrical and accompanied by the palps, the last joint of which is very slender and obtuse; by pressure the broader base of the rostrum is made to protrude (*f*); tarsi (*c*) thickened at the end, with large claws; coxæ of four posterior pairs of legs longer than the others, which is contrary to what occurs in *Hydrachna*, *Atax*, &c.; coxæ of the anterior two pairs of legs closely approximate, as are also those of the two posterior pairs (*e*), but the two groups are widely separated.

The larvæ have six legs, a large head-like rostrum, with two large palps and two black lateral anterior eyes, and fix themselves upon or near the head of *Gerris lacustris*; they subsequently detach themselves from this insect, fall into the water, and pass their nymph-stage under submersed stones, the perfect animal making its appearance at the end of fifteen days.

BIBL. Dugès, *Ann. d. Sc. Nat.* 2 sér. i. p. 159; Gervais, *Walckenaer's Arachn.* p. 208; Koch, *Deuts. Crustac.*, &c.

LIMNODIC'TYON, Ktz.—A genus of Protococcaceæ.

Char. Cells angular from mutual pressure, bound together in membranous layers, and agglomerated in a parenchymatous form. Multiplication by gonidia.

Bibl. Rabenh. *Fl. Eur. Alg.* iii. 61.

LIMNO'RIA, Leach.—A genus of marine Crustacea, of the order Isopoda, and family Asellota.

L. terebrans (Pl. 44. fig. 27) is of interest on account of the great ravages which it commits in submerged timber, as the piles of piers, flood-gates, docks, &c., which it perforates in every direction. Head large, rounded; antennæ four, of nearly equal length; eyes two, lateral, black, composed of about seven ocelli; body elongato-subcylindrical, thorax with seven joints, legs seven pairs, formed for walking; abdomen six-jointed, the last joint large, suborbicular, and with two styles; length about 1-6″. It contracts into a ball when disturbed.

Bibl. Leach, *Linn. Trans.* xi. 370; Coldstream, *Edin. New Phil. Journ.* 1834; Hope, *Entom. Trans.* i.; Dalyell, *Wonders of Creation*, i.

LINDIA, Duj.—A genus of Rotatoria, of the family Hydatinæa, E. (Furcularina, Duj.).

Char. Body oblong, almost vermiform, with transverse folds, rounded in front, but no rotatory organ, cilia, or eye; tail-like foot with two conical and short segments or toes; jaws very complicated (and imperfectly described).

L. torulosa (Pl. 34. fig. 40). Aquatic; length 1-75″.

Bibl. Duj. *Infus.* p. 653; Cohn, *Sieb. & Köll. Zeitsch.* 1858, p. 286; Pritch. *Infus.*

LINDSÆA, Dryander. — A genus of Davallieæ (Polypodioid Ferns). Exotic (fig. 404).

LINGULI'NA, D'Orb.—A hyaline stichostegian Foraminifer, differing from *Nodosaria* in being laterally compressed and having a slit-like aperture.

Bibl. Carpenter, *Introd.* 163.

LINGULINOP'SIS, Reuss.—This may be defined as a *Lingulina* having its early chambers coiled, or a *Marginulina* much compressed and opening with a rift.

Bibl. Reuss, *K. böhm. Ges. Wiss.* 1860.

LI'NUM, L. See Flax.

LIOSI'PHON, Ehr.—A genus of Trachelina (Infus. Ciliata).

Char. Resembles *Nassula*; but the frontal region is prolonged. 1 species.

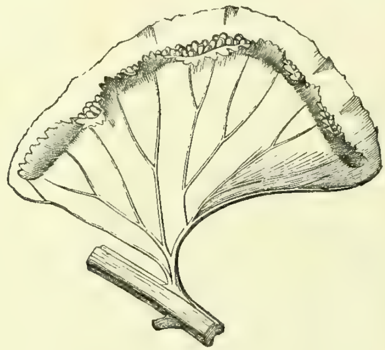
Bibl. Pritchard, *Infus.* p. 627.

LIOSTEPHAN'IA, Ehr.—A genus of Melosireæ (Diatomaceæ).

Char. Frustules simple, orbicular; disk smooth, but with a crown of rays round a smooth space. 3 species. From Barbadoes.

Bibl. Pritchard, *Infus.* p. 813.

Fig. 404.



Lindsæa.
A pinnule. Magn. 10 diams.

LIOTHE'UM, Nitzsch.—A genus of Insects, of the order Anoplura, and family Liotheidæ.

Char. Antennæ clavate or capitate; maxillary palpi conspicuous; mouth with strong mandibles; tarsi with two claws.

Antennæ four-jointed; mandibles with two teeth; maxillary palpi long, filiform, four-jointed; labial palpi very short, two-jointed.

The genus has been subdivided into seven subgenera. The species are very numerous, and are parasitic upon birds.

L. (*Menopon*) *pallidum* (Pl. 28. fig. 7). Elongate, of a pale straw colour, shining and smooth; head slightly sinuate on each side, with a dark pitchy spot before each eye. Length 1-24 to 1-16″. Common upon the domestic fowl.

Bibl. Denny, *Anoplur. Monogr.* p. 204.

LIPAROGY'RA, Ehr. — A genus of Melosireæ (Diatomaceæ).

Char. Frustules simple, cylindrical, each having an internal spiral filiform band or crest.

Bibl. Pritchard, *Infus.* p. 823.

LIPEU'RUS. — A genus of parasitic Arachnida (*L. phœnicopteris*) found on flamingoes.

Bibl. Macalister, *Qu. Mic. Journ.* 1871, p. 163.

LIRADIS'CUS, Grev.—A genus of Diatomaceæ.

BIBL. Greville, *Mic. Trans.* 1865.

LITHIC ACID. See URIC ACID.

LITHOCYS'TIS, Allm.—A genus of Corallinaceæ (Florideous Algæ), consisting of a single species, *L. Allmanni*, Hass., which has been found as an epiphyte, forming minute white dots upon *Chrysimenia clavellosa.* The minute dots consist of one or more fan-shaped fronds composed of square cells. The plant is colourless, brittle, and effervesces in acid. The fan-shaped frond somewhat resembles in structure imperfect or segmental fronds of COLEOCHÆTE.

BIBL. Hass. *Brit. Mar. Alg.* p. 111, pl. 14 B; *Phyc. Brit.* pl. 166.

LITHODES'MIUM, Ehr.—A doubtful genus of Diatomaceæ. Marine.

L. undulatum (Pl. 13. fig. 4 *a*, front view; 4 *b*, side view). Surface without markings, very pellucid, two of the sides undulate, the third plane and with two marginal notches; angles obtuse; length of joints 1-480″.

BIBL. Ehr. *Abh. d. Berl. Akad.* 1840; Kütz. *Bacill.* p. 135, and *Sp. Alg.* p. 133.

LITHOFELLINIC ACID.—This substance is a component of certain concretions called bezoars, and found in the alimentary canal of various kinds of goat in the East, as in Persia &c.

It is crystalline, insoluble in water, readily so in hot alcohol, but little in ether.

The perfect crystals form six-sided prisms with truncated ends; but when somewhat rapidly deposited from an alcoholic solution, they are modified as represented in Pl. 7. fig. 14.

BIBL. See CHEMISTRY.

LITHOGRAPHA, Nyl. — A genus of Lichens.

Char. Thallus crustaceous or evanescent; apothecia lirellæform, black, tumid; epithecium rimiform, margins thick, convex; hypothecium black, thick, entire; spores 8 or numerous, simple or 1-septate.

5 British species. Rare.

BIBL. Leighton, *Brit. Lich. Flor.* p. 360.

LITOSI'PHON, Harv. — A genus of Punctariaceæ (Fucoid Algæ), with fronds composed of cartilaginous filiform unbranched filaments, at first solid, afterwards tubular, composed of several rows of cells; epiphytic on *Chorda filum* (*L. pusillus*) and *Alaria* (*L. Laminariæ*), the former 2 to 6″ long, the latter 1-4 to 1-2″. The sporanges occur either solitary or aggregated, scattered on the surface of the filaments, which in *L. pusillus* are clothed with pellucid hairs, in *L. Laminariæ* smooth.

BIBL. Harv. *Brit. Mar. Alg.* p. 43, pl. 8 D; Thuret, *Ann. des Sc. Nat.* 4 sér. iii. p. 14.

LITU'OLA, Lamarck.—A protean Foraminiferal genus, abundant both recent and fossil; characterized by the test being coarsely arenaceous, with little or no calcareous cement. The shell may be unilocular (*Proteonina,* Williamson). If compound, its shape may be loosely moniliform (*Reophax,* Montfort), whether straight, coiled, or irregular, free or attached (the latter feature characterizing *Placopsilina,* D'Orb.). Or the chambers may be close-set and overlapping, and have either a straight, coiled, or crozier-like contour, imitating various forms of other Foraminifera, such as *Orthocerina, Nodosaria, Flabellina, Cristellaria, Spirolina, Rotalia, Nonionina, Globigerina, Orbulina,* &c. Further, the chambers may communicate by a simple central aperture, or by a cribriform septal plate; and they may be either simply hollow, or labyrinthic from secondary growths. Some with a single aperture and undivided chambers, and some which are labyrinthic and cribriform, belong to Reuss's *Haplophragmium, Haplostiche* (straight), and *Polyphragma* (large and thick). When the aperture is of a horse-shoe shape and subvalvate, we have the *Hippocrepina,* Parker. Pl. 18. fig. 18 is an irregularly nautiloid, labyrinthic form (*Lituola difformis*) very common in the Chalk.

BIBL. Carpenter, *Introd.* p. 143.

LITUO'LIDA, Carp.—Besides the coarse-grained genus *Lituola* (with its subdivisions), there are several closely related forms which differ chiefly in the degrees of smoothness and compactness with which the constituent sand-grains, and sometimes spicula, are set and cemented.

Botellína, Carpenter, is a long, roughly segmented tube of sand and spicules, with ill-defined terminal aperture. *Saccammína,* Sars, is spherical and smooth, either single or in twos and threes united by a narrow stolon-tube. This is found fossil in the Lower Carboniferous strata, as well as recent. *Pilulína,* Carpenter, quite spherical, with a fissure-like mouth, is composed of very fine sand and points of spicules. *Astrorhíza,* Sandahl, relatively large, has a coarse, irregularly stellate, test of loosely aggregated sand, with pseudopodial apertures among the granules, chiefly at the ends of the digitate radii. *Rhadammína,*

Sars, arenaceous, with a cement containing ferric phosphate, is tubular, forked, or radiate, usually trifid, with a central cavity; openings at the radial ends.

The *Lituolida* with fine-grained and smooth tests are best typified by *Trochammina* and its subgenus *Webbina* (D'Orb., restricted). These range from simple, attached, tent-like, single or multiple tests (*W. hemisphærica*, *W. irregularis*, &c.), to the tubular and spiral *Troch. incerta* (Pl. 18. fig. 14) and the rotalioid *T. squamata* et *inflata*. The rotalioid and fusuline *Endothyræ* and the nummulitoid *Involutina*, all fossil, belong to the same category.

Valvulina, sometimes finely, sometimes coarsely arenaceous, is, in this character, intermediate to the Lituolines and Trochammines; and among its several modifications some link it with *Lituola* and others with *Trochammina*. *Tetrataxis* has an alternation of *four*, and *Valvulina* (Pl. 18. fig. 20) of *three* chambers.

The *Lituolida* are represented in every existing sea, and in every geological formation as far back as the Carboniferous.

Bibl. Carp. *Introd.* p. 140; *Descr. Cat. R. Mic. Soc.* April 1870, p. 4; Parker, Jones, and Brady, *Phil. Trans.* vol. clv. p. 406; *Monogr. Crag For. Pal. Soc.* p. 25; *Geol. Mag.* vol. i. p. 193; *Rep. Brit. Assoc.* 1869, Sections, p. 381; *Ann. Nat. Hist.* ser. 4. vol. x. p. 261, March 1871.

LIVER.—It need scarcely be said that the liver is the glandular organ which secretes the bile.

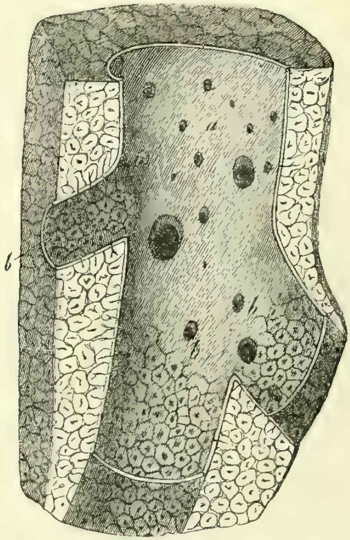
On examining the surface of the liver or a transverse section of that organ with the naked eye, it usually presents a mottled appearance, numerous spots of a dark or light red colour being surrounded by a margin of a paler or darker colour. These spots correspond to the lobules of the liver.

The lobules are rounded or polygonal, and about 1-2 to 1''' in diameter (fig. 405).

Between the lobules run branches of the vena portæ, forming the interlobular veins (coloured red in Pl. 31. fig. 33); these throughout their course send off numerous smaller branches into the substance of the lobules, which terminate in the capillary plexus of the lobules.

The branches of the vena portæ are accompanied by branches of the hepatic duct and ramifications of the hepatic artery, the whole being surrounded by areolar tissue prolonged from Glisson's capsule. Hence, in a section of the uninjected liver, those branches of

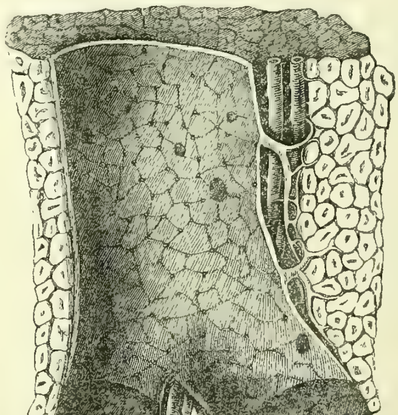
Fig. 405.



Magnified about 3 diameters.

Portion of the liver of a pig, with divided branches of the vena cava; the lobules are visible upon the divided surfaces: *a*, large vein, no orifices of the intralobular veins being visible; *b*, branches of the same, with distinct orifices of the intralobular veins, and the bases of the lobules seen through their walls.

Fig. 406.

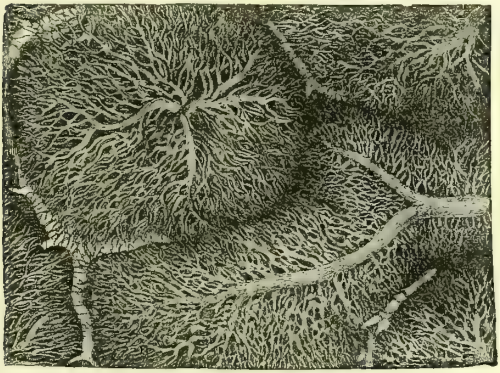


Magnified about 4 diameters.

Section of the liver of a pig through a branch of the vena portæ, with accompanying branches of the hepatic artery and duct. On the right are seen two branches of the vena portæ giving off the interlobular veins.

the vena portæ and of the vena cava which are visible to the naked eye are readily distinguishable from each other by the orifices of the former collapsing, whilst those of the latter are kept open by their close contact with the lobules.

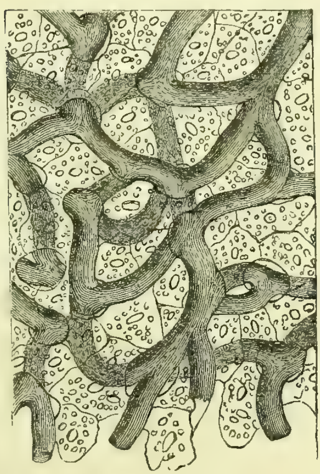
Fig. 407.



Magnified 35 diameters.

Section of a portion of the liver of a rabbit, showing the entire course of one of the intralobular veins, the roots only of the others.

Fig. 408.



Magnified 350 diameters.

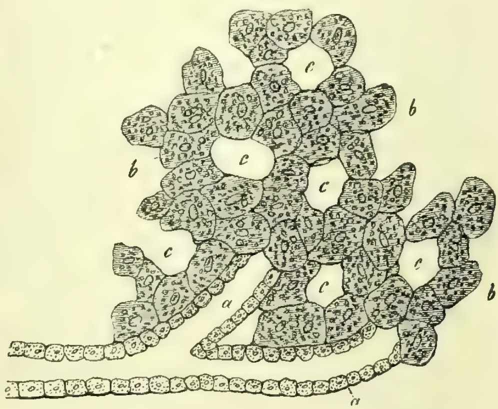
Secreting cells and capillaries of the liver of a pig. [The spaces between the capillaries and the cells have been left through error of the draughtsman.]

In the centre of each lobule arises a branch of the vena cava, by the union of numerous smaller branches (coloured yellow in Pl. 31. fig. 33), which take their origin in the capillary plexus of the lobule; these central branches form the intralobular veins.

The capillaries of the lobules form a close and elegant plexus between the branches of the inter- and intralobular veins, the rest of the lobules being filled up with the secreting cells (fig. 408).

The branches of the biliary ducts accompany those of the vena portæ as far as the interlobular spaces, where, according to many authorities, they do not enter the lobules, but terminate in cæcal extremities; but this arrangement is stoutly denied by others, who consider that the minute hepatic cell-tubules open into them. The biliary ducts consist of an outer coat of areolar tissue, the bundles of fibres of which are difficultly separable, and an internal epithelial layer. The areolar coat is most distinct in the larger branches, being almost

Fig. 409.



Magnified 350 diameters.

Secreting cells and terminal interlobular ducts; human. *a*, ducts; *b*, cells; *c*, spaces occupied by blood-vessels.

absent in the terminal interlobular ducts; it contains numerous nuclei and nuclear fibres. The epithelium of the larger ducts is cylindrical, that of the smaller of the pavement kind. In the hepatic ducts the outer coat contains scattered muscular fibre-cells. The ducts also contain small mucus-

glands. The secreting cells of the lobules fill up the interspaces between the blood-vessels, forming a network with radiating meshes. They are very transparent, of a rounded or polygonal form, about 1-1000" in diameter, containing a nucleus or not unfrequently two nuclei, with a number of granules, and a few small globules of fat (fig. 160, page 227).

It is still an open question whether or not these cells are united serially within a structureless membrana propria, forming the so-called hepatic tubules, through which the bile passes to the ducts.

The division of the substance of the liver into lobules is rather apparent than real, being effected by the peculiar arrangement of the vessels, the lobules having no true coat or envelope. The areolar tissue which accompanies the vena portæ and its branches becomes less and less in quantity as the branches become smaller, and is lost in the interlobular spaces. It is much more abundant in animals, as the pig, than in man, rendering the lobular arrangement much more distinct.

The branches of the hepatic artery are distributed to the portal vessels, the hepatic ducts, Glisson's capsule with its prolongations, and the peritoneal coat. They are often elegantly tortuous.

Among the more common morbid states of the liver may be mentioned:—that called cirrhosis, in which the areolar tissue is excessively developed and mixed with a large number of fibro-plastic corpuscles, producing an atrophied state of the epithelial structure; an increase in the amount of fatty matter in the cells (fig. 160, page 227); and the presence in these also of granules of the pigment of the bile, rarely with crystals of cholesterine and bilifulvine.

The examination of the arrangement of the blood-vessels is best made in a liver which has been injected with two kinds of injection, as yellow (chromate of lead) and red (vermilion), or red and white (carbonate of lead)—the yellow or white being injected into the hepatic vein. As the injection is being proceeded with, the surface of the liver should be examined with a lens to ascertain whether the intralobular veins are well filled, and the injection has reached the capillaries; the red injection should then be thrown into the portal vein until it is filled. The general vascular arrangement is best observed in an injection in which the capillaries themselves are not filled, but only the smaller portal and hepatic branches.

To examine the ducts as to their course and termination, the portal vein should previously be injected. If this be not done, the injection easily bursts through the walls of the terminal ducts, and escapes into the intralobular plexus; and thus the appearance of a plexus of vessels prolonged from the terminal ducts is produced.

The structure of the hepatic cells is easily seen on scraping the surface of a section of the liver, and placing the portion thus obtained between two pieces of glass as usual.

The general arrangement of the secreting cells is observed in sections made with Valentin's knife.

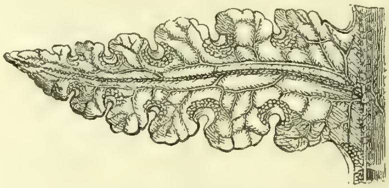
In many animals, as fishes, the loading of the cells of the liver with fat, which in man represents the morbid state of fatty degeneration, is normal, and renders it a matter of some difficulty to distinguish clearly the outlines of the cells, which are also very delicate.

Bibl. Kölliker, *Mik. Anat.* ii.; Kiernan, *Phil. Trans.* 1833; H. Jones, *Phil. Trans.* 1846 and 1849; Guillot, *Ann. des Sc. Nat.* 3 sér. 1848; Leidy, *Sill. Jn.* 1848; *Beale, On the Liver*; Carpenter, *Phys.* 4th edit.; Ewald Hering in *Stricker, Histol., New Syd. Soc.* vol. ii. and the authorities mentioned therein.

LOASACEÆ.—A family of Dicotyledonous Flowering plants, with stinging hairs upon the epidermis. *Loasa, Bartonia,* and *Blumenbachia* are often to be obtained in gardens.

LONCHI'TIS, Presl.—A genus of Adianteæ (Polypodioid Ferns). Exotic (fig. 410).

Fig. 410.



Lonchitis pubescens.
A pinnule with sori.
Magnified 10 diams.

LOFTU'SIA, H. B. Brady.—A large fusiform arenaceous Foraminifer, consisting of a spiral lamina, secondary oblique longitudinal septa, and tertiary vertical divisions,

making the internal structure labyrinthic. In texture similar to the higher *Trochamminæ*, *Loftusia* stands high amongst the arenaceous forms, corresponding with *Alveolina* in the Porcellaneous, and *Fusulina* in the Hyaline group. Fossil in Persia.

BIBL. Brady, *Phil. Trans.* 1869, 751.

LO'PHIUM, Fr.—A genus of Phacidiacei (Ascomycetous Fungi), remarkably distinguished by the form of the *perithecia* resembling a bivalve shell with the valves *in situ* (figs. 411 & 412). The nucleus contained

Fig. 411. Fig. 412. Fig. 413.

Lophium mytilinum.
Fig. 411. A perithecium, seen sidewise.
Fig. 412. The same, seen endwise.
Fig. 413. A perithecium cut open.
Magn. 25 diams.

within the carbonaceous perithecium consists of erect asci mixed with paraphyses, containing minute spores, and soon falling away into a powder. *L. mytilinum*, Pers. (figs. 411–13), occurs on the bark or naked wood of fir trees. *L. elatum*, Carm. also occurs on fir wood. These plants are known from allied genera by the remarkable form of the perithecia.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 280; Fries, *Syst. Myc.* ii. p. 533; *Summa Veg.* p. 401; Greville, *Sc. Crypt. Flor.* pl. 177.

LOPHOCO'LEA, Nees.—A genus of Jungermannieæ (Hepaticæ), including the *J. bidentata*, L., and *J. heterophylla*, Schrad., growing in moist situations, at the roots of trees, &c.

BIBL. Hook. *Brit. Jungerm.* pls. 30, 31; *Brit. Flor.* ii. pt. 1. p. 122.

LOPHOPO'DIUM, Ktz.—A genus of Rivulariaceæ of doubtful value and allied to *Amphithrix*.

BIBL. Rabenh. *Fl. Eur. Alg.* ii. 231.

LOPHO'PUS, Dumortier.—A genus of freshwater Polyzoa, of the order Hippocrepia, and family Plumatellidæ.

Char. Polypidom sacciform, hyaline, gelatinous, with a disk serving for attachment; orifices scattered; ova elliptical, with a ring, but no spines.

BIBL. Allman, *Fresh. Polyzoa* (*Ray Soc.*), 83; Johnston, *Brit. Zooph.* 391.

LORI'CA. See CARAPACE.

LOUSE. See PEDICULUS and ANOPLURA.

LOVENEL'LA, Hincks.—A genus of Campanulariidæ (Hydroida).

Char. Stems simple or slightly branching, rooted by a thread-like stolon; hydrothecæ turbinate, elongate, operculum of distinct segments; proboscis large and prominent. *L. clausa*, Lovén, from the Oar stone, Torbay.

BIBL. Hincks, *Brit. Hyd. Zooph.* p. 177.

LOXOCON'CHA, Sars.—A marine Ostracode, allied to *Cythere*, with long setiferous antennæ, and strong subrhomboidal valves, which have toothed hinges and often a pitted surface. Common in the British and other seas, and fossil in the Tertiary and post-Tertiary strata.

BIBL. G. S. Brady, *Tr. Linn. Soc.* xxvi. 432.

LOXO'DES, Ehr.—A genus of Infusoria, of the family Trachelina.

Char. As correctly revised by Claparède & Lachmann, the genus is characterized by a row of transparent vesicles, each of which contains a highly refracting body, and by a more or less arborescent distribution of the digestive canal.

There is only one species, *L. rostrum*, Ehr. (*Pelecida rostrum*, Duj.), Pl. 24. fig. 39.

L. bursaria (Pl. 24. fig. 41.) is a Paramecium. *L. cucullulus* and *L. dentatus* belong to *Chilodon*.

BIBL. Ehr. *Infus.* p. 323; Duj. *Infus.* p. 449; Stein, *Infus.* p. 238, &c.; Claparède et Lach. *Etudes*, p. 344.

LOXOPHYL'LUM, Clap. et Lach.—A genus of ciliated Infusoria, fam. Trachelina.

Char. Body flat and leaf-like, even when well nourished; a flat portion surrounds the body, forming a transparent zone into the composition of which the rest of the body does not enter. A contractile vesicle posteriorly near the anus. Sometimes the anterior part of the body is produced. 4 species. Syn. of *L. fasciola* (Pl. 23. fig. 10 *a* & *b*) is *Amphileptus fasciola*, E. & D., but *L. meleagris*, D., is not properly an *Amphileptus*: see p. 35. The other species are *L. armatum*, Clap. et L., and *L. lamella* (*Trachelius lamella*, Ehr.).

BIBL. Duj. *Infus.* p. 487; Claparède et Lachmann, *Etudes*, p. 360.

LOXOSO'MA, R. Brown.—A genus of Hymenophyllaceous Ferns, distinguished by the projecting column bearing the sporangia (figs. 414, 415, 416).

Fig. 414.

Fig. 415.

Fig. 416.

Loxosoma Cunninghamii.

Fig. 414. A pinnule with marginal sori. Magn. 5 diams.

Fig. 415. A sorus opened. Magn. 25 diams.

Fig. 416. Columella with sporanges. Magn. 50 diams.

LUCERNARIA, Fabricius,—A genus of Medusidæ (Jellyfishes), with the tentacula arranged in eight little tufts, pedunculated and bell-shaped. *L. auricula* is common in the summer in the seas of England, Norway, and Greenland. It can be kept for some time in an aquarium, and from the small size of many individuals is a very interesting object for the microscope.

Bibl. M.-Edwards & Haime, *Hist. Nat. d. Corall.* iii. p. 457; A. Agassiz, *Sea-side Stud.* Boston, 1871, p. 46; Keferstein, *Zeit. f. wiss. Zool.* xii. 1862.

LUMBRI'CUS.—A genus of Oligochæta (Annelida). The anatomy and histology of *L. terrestris*, the earthworm, have engaged the attention of many observers. For a description of the anatomy of the species and its bibliography, see E. Ray Lankester, *Qu. Mic. Jn.* 1864 & 1865, p. 114; Lockhart Clarke, *Proc. Royal Soc.* 1857, p. 344 (*nervous system*); Rolleston, *Forms of Animal Life.*

LUNGS.—The internal respiratory sacs of animals.

Under this head hall notice also the larynx, trachea and bronchi

Larynx.—The cartilages of the larynx do not all possess the same minute structure. The thyroid and cricoid cartilages consist of hyaline cartilage, the basis being homogeneous, and containing disseminated cartilage-corpuscles. The walls of the corpuscles are usually thick. The basis often becomes fibrous, and both corpuscles and basis incrusted with calcareous salts, or completely ossified. Their perichondrium is firm, and is composed of areolar tissue, with fine elastic fibres, vessels, and nerves.

The arytenoid cartilages are hyaline centrally, but they become fibrous near their surface.

The epiglottis (Pl. 40. fig. 40) and the appendices of the arytenoid consist of fibrocartilage; and the corpuscles are frequently more or less filled up by secondary deposit. Its cartilage presents numerous excavations on its posterior or inferior surface, which often penetrate it and transmit vessels and small nerves.

The mucous membrane, as also the submucous tissue of the larynx, consists of areolar tissue with networks of fine elastic fibres; at the surface it becomes more homogeneous, but does not form a separable basement layer or membrane. It contains a number of small racemose glands, the vesicles of which are lined with pavement, the ducts with cylindrical epithelium.

The epithelium of the anterior surface of the epiglottis is of the pavement kind; and this gradually becomes changed into the columnar and ciliated kind posteriorly. The margins of the aryteno-epiglottidean folds are covered with an epithelium of tessellated cells, which is continued over the opposed surfaces of the arytenoid cartilages as far down as the level of the lower vocal cords. The projecting border of the true vocal cord is covered with pavement epithelium, which is suddenly replaced towards the ventricle of the larynx and the trachea, by the ordinary ciliated kind.

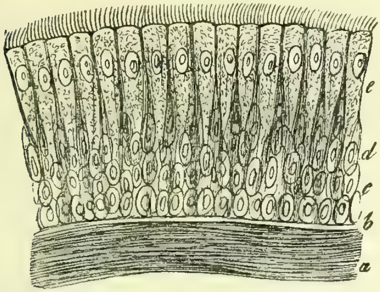
Trachea and larger bronchi.—The incomplete cartilaginous rings of these tubes are surrounded and connected together by a firm, elastic, fibrous membrane, forming their perichondrium, which also covers the posterior part of the tubes as a somewhat thinner layer. The cartilage is of the true kind. At the posterior part of the tubes is a layer of unstriated muscular fibres, most of which form transverse, but a few longitudinal bundles. The elastic tissue of the mucous membrane is greatly developed,

forming a distinct internal layer of principally longitudinal anastomosing fibres.

In the larger bronchi down to those that do not exceed 1-25″ in diameter, there are the following structural pecularities :—

1. There is a tunica adventitia consisting of connective tissue and fat which connects the bronchi with the adjoining tissues. 2. The external fibrous layer, consisting of dense fibrillated connective tissue, with imbedded cartilaginous plates which form flattened semicircles, and are distributed posteriorly as well as around the small

Fig. 417.



Epithelial cells of the trachea *in situ*; human. *a*, longitudinal elastic fibres; *b*, homogeneous outer (basement) layer of the mucous membrane; *c*, deep layers of round cells; *d*, intermediate layers; *e*, outer ciliated cells.

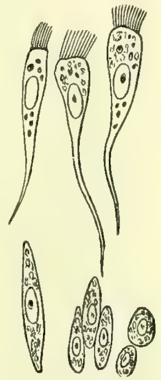
Magn. 350 diameters.

bronchus. Irregular and angular plates succeed these and become rarer with the diminishing calibre of the tube. 3. The muscular layer of compact circular fasciculi of organic muscular tissue. 4. The internal fibrous layer, consisting of thick longitudinal elastic fibres; it is in relation with the longitudinal folds of the next or mucous layer. 5. A loose connective tissue with delicate fibres running longitudinally and becoming condensed into a hyaline layer, where it simulates a basement membrane. On this rests the epithelium. This consists of columnar ciliated epithelium and of cup or goblet cells.

In bronchi of the smallest kind, the external fibrous coat is attenuated, and consists of a few longitudinal fibres; the muscular layer breaks up into isolated circular bands; and the longitudinal elastic fibres of the inner coat continue as compressed fasciculi. The ciliated epithelium cells are not so high. They even assume a flat form; and near the transition into the alveolar passages they lose their cilia, and the cup and goblet cells are no longer found.

The walls of the pulmonary air-cells consist of two layers, a fibrous and an epithelial layer. The former is composed of a basis of homogeneous areolar tissue, with numerous elastic fibres, vessels, and nerves (fig. 419).

Fig. 418.

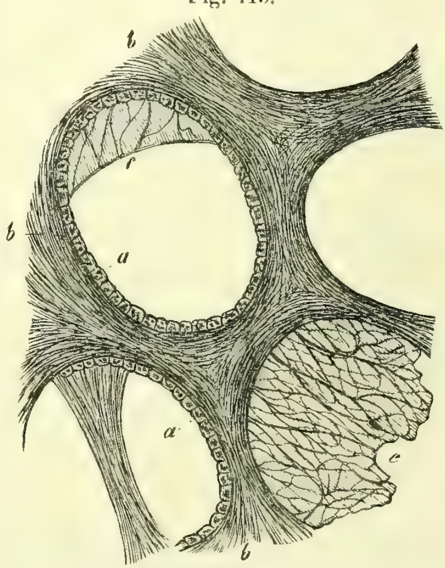


Isolated epithelial cells from the surface of the trachea; human.

Magnified 350 diameters.

The elastic fibres surround the air-cells in the form of elegant wavy bundles and separate fibres which anastomose and constitute a dense network, most obvious at those parts where several cells are in contact with each other; whilst in other parts the areolar element supporting the numerous capillaries predominates, and the elastic elements are more sparing and slender. The epithelium is of the pavement

Fig. 419.



Air-cells of a human lung. *a*, epithelium; *b*, fibrous portion, where the walls of several air-cells are confluent; *c*, thinner walls of air-cells.

Magnified 350 diameters.

kind, not ciliated, consisting of rounded or

polygonal nucleated cells, about 1-2000″ in diameter.

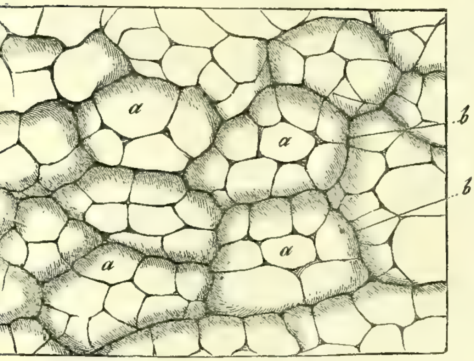
Each terminal bronchus forms an infun-

Fig. 420.

Two pulmonary lobules *a a*, with the air-cells *b b*, and the terminations of the bronchi *c c*; from an infant newly born.
Magnified 25 diameters.

dibulum, and the air-cells or alveoli present a honeycomb appearance on its interior. A

Fig. 421.



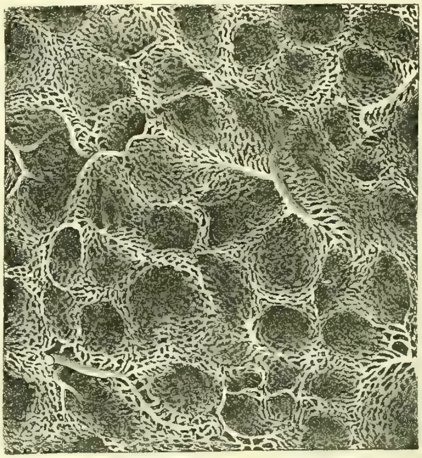
Outer surface of the lung of a cow, the air-cells of which were injected with wax: *a, a, a,* air-cells; *b, b,* boundaries of the (primary) lobules.
Magnified 30 diameters.

group of cells or alveoli belong to each minutest bronchus and constitute a lobule. The walls of the contiguous cells or alveoli form thin septa, the alveolar septa.

The groups of air-cells formingthe lobules of the lungs are separated from each other by areolar tissue mixed with nuclear fibres, containing in adult animals (fig. 421) black pigment in the form of distinct or isolated granules, sometimes also crystals. The lobules are best seen in the lungs of young animals.

These smaller or primary lobules are aggregated to form larger secondary lobules—the lobules of descriptive anatomists, and the outlines of which in adults are principally mapped out by lines of pigment.

Fig. 422.



Capillaries of the human lung.
Magnified 60 diameters.

The lobular structure of the lungs is best shown in the lungs of fœtal animals injected from the trachea or bronchi.

The capillaries of the lungs are extremely minute and very difficult to inject fully; and the finest injection is required for the purpose.

They only lie with a small portion of their diameter imbedded in the tissues of the alveolus; and the rest of their wall is free and in contact with the air of the cells; and where the walls of adjacent alveoli have become fused into a thin membrane, the capillaries once forming a double now exist as a single plexus, and project first into one alveolus and then into the other.

The lymphatics invest the subpleural lobules in the form of a plexus, and dip inwards to join the deep-seated tubes which accompany the bronchi and large vessels to the root of the lung.

In the lower vertebrate animals, the structure of the lungs is much simpler than

in the higher. Thus in the *Triton* each forms a simple tubular sac, whilst in the frog and toad (Pl. 31. fig. 34) each lung may be compared to a single lobule of a lung of the Mammalia, having a cavity in the centre, with which comparatively few large cells extending into the periphery communicate. The capillaries are also much larger, especially in the two animals last mentioned.

The capillaries may often be well seen in thin sections of the inflated and dried organs. The altered structure of emphysematous lungs may also be best shown by this method.

Bibl. Kölliker, *Mik. Anat.* ii.; Rainey, *Med. Chi. Trans.* xxviii. & xxxi.; Stannius, *Vergl. Anat.*; Waters, *Human Lung*, 1860; Henle, *On Lungs*, 1862; Henle, *Eingeweide*, 1866; Verson and M. Schultze *in Stricker's Hum. & Comp. Hist. Syd. Soc.*; Williams, *Todd's Cycl. Anat. and Med. Times*, 1855; Le Fort, *Rech. sur l'Anat. du Poumon*, 1850; Luschka, *Archiv für mik. Anat.* v. p. 1; M. Schultze, *Archiv für mik. Anat.* iii. p. 192.

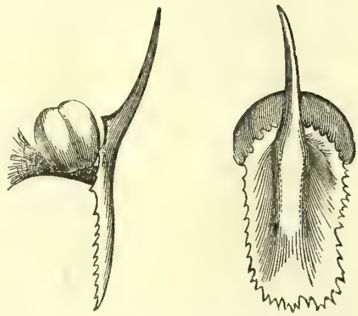
LUNULA'RIA, Michel. — A genus of Marchantieæ (figs. 329–331, p. 377).

LYCOGA'LA, Mich.—A genus of Myxogastres (Gasteromycetous Fungi), consisting of somewhat globular bodies, verrucose on the outside, composed of a double papery peridium, containing capillitium and spores, growing on rotten wood, &c. *L. epidendrum* varies from the size of a pea to that of a nut, is globular when solitary, deformed when growing in groups, and of a red colour. *L. parietinum* is bluish black, and the peridia do not exceed 1-20′′ in diameter.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 307; *Ann. Nat. Hist.* 2 ser. v. p. 365; Grev. *Sc. Crypt. Fl.* pl. 38; Fries, *Syst. Mycol.* iii. 79; *Summ. Veg.* p. 448.

LYCOPODIA'CEÆ. — This order of Cormophytous Flowerless Plants, which derives its name from the *Lycopodia* or Club-mosses, is difficult to characterize in general terms. The bifurcating branched stem, rooting at each fork by a slender thread-like adventitious root, and the ordinarily small overlapping leaves, distinguish most of the species of *Lycopodium*; but there is considerable variation from this habit in the *Psiloteæ*, especially in *Isoëtes*, and the nature of the fructification is the only mark generally applicable. The Lycopodiaceæ bear spores which are found in small dehiscent cases at the bases of the leaves (figs. 423, 426 & 427), on the upper face or imbedded in it; and these fertile leaves are either scattered all along the

Fig. 423. Fig. 424.



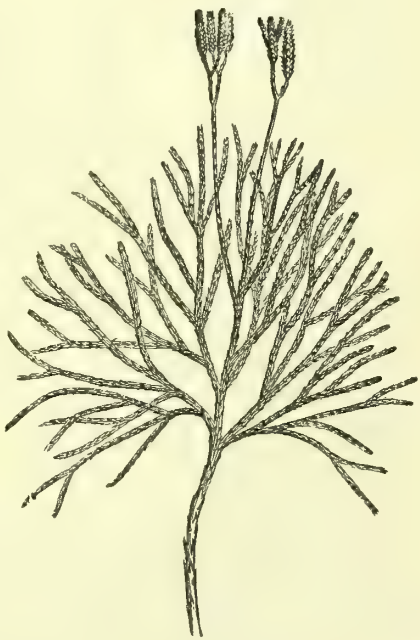
Lycopodium Gayanum.

Fig. 423. Scale of spike with axillary sporange; side view.

Fig. 424. The same seen from the outside.

Magnified 20 diameters.

Fig. 425.



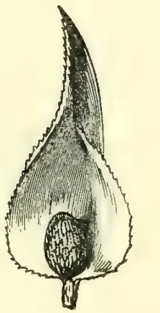
Lycopodium complanatum.

One third the natural size.

stem, or collected into spikes resembling, on a small scale, elongated Pine-cones (figs. 425,

435). The plants of the genus *Lycopodium* proper, exhibit both these conditions; but

Fig. 426. Fig. 427.



Selaginella apoda.

Fig. 426 Scale with oosporange. Magn. 20 diams.
Fig. 427. Scale with pollen-sporange. Magn. 20 diams.

find the capsules on the lowest scales (*oosporanges*) producing only four spores (figs. 426, 428), of much larger size than those contained in large number in the other spore-cases (*pollen-sporanges*) (figs. 427, 429). In *Lycopodium* and *Selaginella*

Fig. 428. Fig. 429.

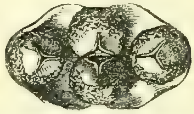


Fig. 428. Oosporange with four large spores. Magn. 20 diams.
Fig. 429. Pollen-sporange burst, containing small spores. Magn. 20 diams.

the sporanges have but one cavity; in *Tmesipteris* the sporanges are two-celled, and in *Psilotum* three-celled. In *Isoëtes* (fig. 376, p. 432), where all the leaves are seated on a tuberous stem, and most of them fertile, the sporanges containing spores of each kind are many-celled, and immersed in the substance of the bases of the leaves.

The anatomical structure of the stem of the Lycopodieæ is not very complex. There is an outer thickish rind, composed of cellular tissue; and on cutting across a stem, the ends of isolated fibro-vascular bundles are sometimes seen traversing this; these isolated bundles are merely a portion of those forming a kind of cord running up the centre of the stem, whence they have been sent off to supply the leaves. The fibro-vascular bundles are composed of spiral-fibrous ducts surrounded by elongated cellular tissue (see Tissues, vegetable), which in large woody stems become lignified by secondary deposits. The roots have also a central fibro-vascular cord, connected with the central cord of the stem. The structure of the little-developed

Fig. 430.

Selaginella cernua. Half natural size.

n all these the spores are small and numerous. In *Selaginella*, to which belong the elegant creeping Club-mosses, with flattened leafy stems (often with a metallic lustre), now so much grown in Wardian cases (fig. 430), the capsular leaves are in spikes, which are found forming one arm of a bifurcation of the stem, while the other continues the vegetative growth; and in these spikes we

tuberous stem of *Isoëtes* is very different, and exhibits a remarkable mode of growth, forming annual layers of woody structure (see ISOËTES).

The leaves are of very simple structure; but their arrangement exhibits many curious peculiarities. In PSILOTUM, one of the simplest forms, where they are mere minute scales on a widely bifurcated stem, they are alternate; in some *Lycopodia* they are opposite, in others whorled. When the leaves are in whorls, they vary in number, not only in different species, but often in the same species in different localities, or even in the same plant: thus, the arrangement is often different on the main stem and on the branches.

When the leaves are opposite, those forming the pairs sometimes differ both in dimensions and form; in *Lycopodium complanatum* (fig. 434), the pairs of opposite leaves cross alternately at right angles, so

Fig. 432.

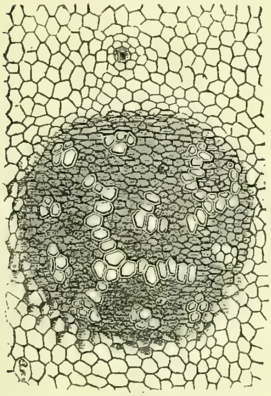


Fig. 431.

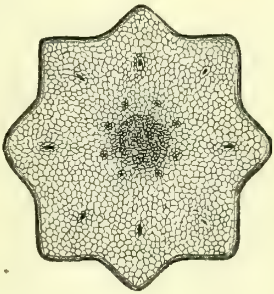
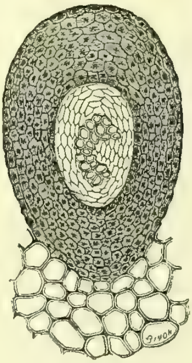


Fig. 433.



Lycopodium phlegmarium.

Fig. 431. Section of the stem. Magnified 20 diameters.
Fig. 432. The centre of ditto. Magnified 100 diameters.
Fig. 433. One of the isolated bundles of ditto. Magnified 200 diameters.

Fig. 434.

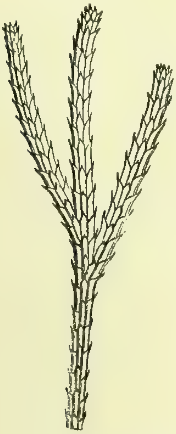


Fig. 435.

Fig. 436.

Fig. 434. Lycopodium complanatum. Young shoot.
Fig. 435. Lycopodium lucidulum. Spike of fruit. Magnified 3 diameters.
Fig. 436. Selaginella apoda. Young shoot. Magnified 2 diameters.

as to form four rows up the stem; in two (opposite) rows the leaves are alike and flattened laterally; of the other two rows, one consists of leaves like the two just described, but flattened against the stem; and the fourth row (opposite the third) of minute scale-like bodies. In other cases, in *Selaginella apoda* for example (fig. 436), the corresponding leaves of the pairs are unequal, and are so arranged that the smaller lie in two contiguous vertical rows, on the front of the stem. In most of the Lycopodiaceæ the leaves are simple and almost sessile; but in *Tmesipteris* they have a blade developed into two lobes and borne on a long stalk; and in *Psilotum* the short scale-like leaf is also divided into two lobes and supported on a petiole. The leaves of *Isoëtes* are different (see ISOËTES).

The reproduction of the Lycopodiaceæ is very curious; it is only accurately understood as yet, however, in the genera *Selaginella* and *Isoëtes*, in which, as above stated, two kinds of spore are known to exist. It is found that when both kinds of spore are sown, the results of their germination are totally distinct. The small dust-like spores burst their outer coat after a time; and the delicate inner membrane, which is protruded, likewise bursts subsequently and discharges extremely minute cellules, in each of which is developed an actively moving spiral filament (spermatozoid) like those of the FERNS. This breaks out and swims about rapidly in the water when seen beneath the microscope.

The large spore exhibits no external change for a period varying from a few weeks to a few months; but a section shows that a process of cell-formation has commenced in its interior, which results in the production of a kind of disk of cellular tissue in the upper part, beneath that portion of the outer spore-coat which exhibits the three converging ridges produced by the pressure of the four spores in the parent sac during their development. At this period the spore appears to have three coats—an outer, tough, coloured coat, a second coat lining this, and a third which lines the second over the great cavity of the spore, but at the upper part invests the inside of the newly-formed disk of cellular tissue, which thus lies between the second and third coats. This disk of tissue is a *prothallium*; and on its upper surface are developed a number of *archegonia* of very simple structure. A cell of the substance of the *prothallium*, taking on the function of an *embryo-sac*, develops a free cell (*embryo-cell*) in its interior; and the cells between this and the surface become modified and part, so as to leave an intercellular canal between the contiguous angles of four adjoining cells, leading down to the embryo-cell,—the four cells growing up from the surface so as to form a kind of perforated cellular papilla, something like that of the archegone of the Ferns. At a certain stage of this development, the outer coat of the spore bursts at the converging ridges, and the angular flaps resulting turn back and expose the prothallium on the upper surface. One (sometimes two, but as an irregularity) of the embryo-cells is then fertilized by the spiral filaments (spermatozoids) produced by the small spores (antheridial or *pollinic spores*), if these exist at the right stage of the development in the vicinity. After this, the embryonal cell undergoes multiplication, first growing down as a cellular filament which breaks through into the great cavity of the spore. The lower end lying there then increases until it acquires the form of a cellular nodule, which breaks out above and exhibits on its free portion the first adventitious root and the first pair of leaves. The rootlet makes its way downwards into the soil; and the leaves are gradually elevated on a thread-like stalk, and separate, displaying two terminal buds between them, whence the first bifurcation of the stem proceeds.

This mode of reproduction allies the family very closely to the double-spored Marsileaceæ, and separates them from the Ferns and Equisetaceæ, in which the prothallium is formed outside the spores, after the germination of the single and only kind of spore which these plants possess. But a difficulty still exists with regard to those species of Lycopodieæ in which only the smaller kind of spore has been met with, such as our common *Lycopodium clavatum*, *inundatum*, &c. No one has yet been able to raise these from the spores, although De Bary has lately observed their earliest stages of germination, in which they form a little cellular nodule. But some late researches tend to prove that both *archegonia* and *antheridia* are produced in the same spore in *Lycopodium*.

The order Lycopodiaceæ is divided into two families, in accordance with the structure of the sporanges.

Families.

I. LYCOPODIEÆ. Sporanges simple, one-celled.

II. PSILOTEÆ. Sporanges compound, many-celled.

BIBL. Hofmeister, *Vergleich. Untersuch.* Leipsic, 1851, p. 111, &c.; Mettenius, *Beitr. zur Botanik,* Heidelb. 1850; De Bary, *Ann. des Sc. Nat.* 4 sér. ix. p. 30, *Ann. Nat. Hist.* 3 ser. iii. p. 189; J. Faukhauser, *Botan. Zeit.* January 1873; E. Strasburger, *Bot. Zeit.* February 1873. See also ISOËTES.

LYCOPODI'EÆ.—A family of Lycopodiaceous plants, distinguished by their simple one-celled sporanges. The existing kinds are all herbs, mostly creeping over the ground; but some of the fossil kinds, met with especially in the Coal-measures, were large trees, the Lepidodendra.

Genera.

1. *Lycopodium,* Linn. Sporanges all of one kind, containing numerous small spores resembling pollen-grains.

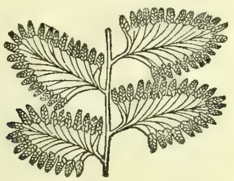
2. *Selaginella,* P. de Beauv. Sporanges of two kinds, the greater part resembling those of *Lycopodium*; one, situated at the base of the spikes, larger, often four-lobed, and contaiaing only four large spores.

LYCOPO'DIUM, Linn.—A genus of Lycopodieæ. This has already been sufficiently characterized under the head of Lycopodiaceæ. There are more than half-a-dozen British species, mostly alpine plants; but *L. inundatum* occurs on bogs in all parts of Britain.

BIBL. Hook. *Brit. Flora*; Babington, *Man. Brit. Botany*; Francis, *British Ferns and their Allies,* 5th ed. See also under LYCOPODIACEÆ.

LYGO'DIUM, Swartz.—A genus of Schizæous Ferns, consisting of beautiful climbing

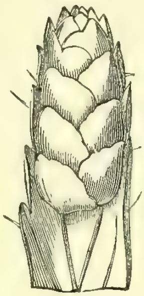
Fig. 437.

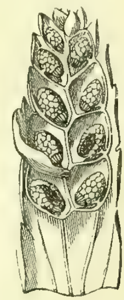


Lygodium reticulatum.
Portion of a leaf, with fertile pinnules. Nat. size.

plants, with conjugate, palmate, lobed or pinnate leaves, having the sessile sporanges in double rows on the teeth of the pinnules

Fig. 438. Fig. 439.





Lygodium reticulatum.

Fig. 438. Tooth of a pinnule with overlapping indusia. Magn. 20 diams.
Fig. 439. The same, with the indusia removed to show the sporanges. Magn. 20 diams.

(fig. 437), each having a hood-like special indusium (figs. 438, 439).

LYMPHATIC SYSTEM.—The lymph-canals or lymphatics form a system the rootlets of which are distributed through the tissues; it communicates with the blood-vessels, drawing a fluid from the capillaries and returning it to the veins by its terminal trunks. The canals are most plentiful in the more vascular tissues; and their contents are moved in obedience to the impulsive force of the blood-vessels. The system may be divided into two sections:—1. the efferent canals or proper lymphatic vessels; 2. structures which contain the fluid and circulate it around the several elements of the organs, the interstitial serous spaces. 1. agree in their form, arrangement, and structure with the blood-vessels. They form cylindrical tubes and are *capillary* where they are intercalated between the system of blood-capillaries, and *larger lymphatics* where they unite to form the main trunks. The larger lymphatics consist of a tunica adventitia of loose connective tissue; and within it is the tunica media, consisting of muscular elements. It supports the tunica intima, which is rich in elastic fibres, and is lined with tessellated epithelium. They are provided with numerous valves resembling those of the veins, which consist of duplicatures of the tunica intima. A single layer of flat epithelial cells lines the tunica intima, and is continued into the capillary lymphatics, where the cells often have nuclei. These small tubes have a special wall, but it does not appear to be homogeneous or perfect; for minute openings not bigger than an epithelial cell exist in it in certain

positions (*stomata*), and also small *foramina* between the epithelial cells or at the point of junction of several. These last appear especially in relation with serous and absorbing membranes.

It is believed by many histologists that they have demonstrated *stomata*, by which superficial lymphatic vessels communicate with the free surface of serous membranes. Dybkowski asserts that the superficial lymphatic vessels lead freely between the endothelium of the surface of the costal pleura of man by short vertical branches. Ludwig and others state that the peritoneum of the centrum tendineum has a fenestrated arrangement in those parts which cover the straight lymphatics; and Recklinghausen demonstrated the existence of irregularly distributed fissures amongst the endothelium above the straight lymphatic channels in preparations in which nitrate of silver was used. He believes these to be stomata. E. Klein distinguishes two kinds of stomata on the surface of serous membranes, namely stomata vera and stomata spuria. The stomata vera are also of two kinds. (*a*) They represent the mouth of a vertical lymphatic channel, which is lined by a special layer of endothelium, and which channel leads into the cavity or lumen of a superficial lymphatic vessel; (*b*) they represent a discontinuity between the endothelium of the surface leading into a simple lymphatic sinus near the surface, and which represents a cavity lined on one side with an endothelium. Both kinds of stomata vera are bordered by endothelial elements of a more or less distinct germinating character. The first kind of stomata are to be found on the peritoneal surface of the centrum tendineum, and on the omentum, mesentery, and pleura. They are extremely short, but they are lined with a special layer of endothelium.

2. *Serous canals* traverse the connective tissues, whether they form the exclusive structure of an organ or are intercalated between the special structures of some other tissue; and they are directly continuous with the lymphatic vessels. The canals often form a plexus; and portions appear to be branched in a stellate manner, exactly resembling the connective-tissue corpuscles. These last occupy the interior of the serous canals, and may extend into the cavity of the lymphatic vessels. The serous canals have not a special wall, and are excavations in the substance of connective tissue, the elements of which are bound together by a tenacious material. They assume, according to the nature of the including organ or tissue, the appearance of wide and dilated cavities (lacunæ), and subcylindrical canals elongated or expanded. The serous canals represent irregular spaces, which are continuous with the capillary lymphatics, whose roots they form, and they conduct the proper fluids of the tissues into the collecting lymphatic capillary system. Probably the serous canals are continuous with minute blood capillaries, in the same manner as is the case with the lymphatic capillaries.

The Follicles.—Many parts of mucous membranes and of some organs are richer in lymph-corpuscles than others; and this is proved from the existence of lymphatic follicles. These are small spherical bodies, which are in relation with great groups of lymphatic vessels and lacunæ. The surface of each follicle is invested by a close network of lymphatic vessels; and often a dilated lacuna separates the vessels of closely placed follicles. The follicle has its extremity uncovered, and consists of a reticulum of very fine fibrils, in the meshes of which are the lymph- corpusclelike cells.

The lymph-glands, glandulæ lymphaticæ. —The glands which lie in the path of the large lymphatic vessels are composed of cortical and medullary portions, which, however, are more or less intermingled. Three separate parts may be distinguished in each gland—the trabeculæ, the follicular tissue, and the lymph-path. The trabeculæ are groups of fasciculi of fibrils of connective tissue, and are direct processes from the cortical sheath which pass into the medullary part of the gland, being at first flat septa and near the centre cylindrical or subcylindrical cords. They become continuous with the connective tissue of the hilus of the gland. At first they enclose alveolar-like spaces; and as they become cylindrical the spaces become smaller, but in much more free communication with each other. The follicular tissue forms rounded cord-like masses, connected with each other in a plexiform manner; they are often moniliform, and constitute the globular dilatations, the outlines of which may be seen on the surface of the glands. But the follicular tissue, although environed by the trabeculæ, is separated from them by a space which is occupied by the lymph-path. The follicular cords have the same tissues as the follicles (see above), and consist of a reticulum of fine fibres, enclosing lymph- corpusclelike

cells. These cells give the opacity to the structure; and although subjected to a slow circulation, they rest much longer here than elsewhere. The capillary blood-vessels abound in the follicular cords; but only larger blood-vessels are found in the surrounding lymph-path and the trabeculæ. The lymph-path, which exists between the follicular cord and the trabeculæ, has a different shape in the alveolar part than in the cylindrical portion of the trabecular arrangement; and spaces both in the form of lacunæ and cylindrical tubes are found in it, which open externally into the different lymphatics found on the surface of the gland. Internally the lacunæ and tubules of the lymph-path become very tortuous and greatly dilated. They embrace portions of the follicular cord, which projects into their lumen, and which is lined with epithelium. These dilatations are the roots of the efferent vessels of the gland; and there is an evident relation between the follicular cord, its lymph, the dilated spaces of the lymph-path and the external canals and vasa afferentia. For LYMPH, see CHYLE.

Lymphatics in Amphibia.—The structure and arrangement of the larger lymphatics differ in the Amphibia. They do not form cylindrical tubes, but lacunæ, which occupy the interspaces between the different organs. These are sacs without any definite form; and their limits are formed by such condensed layers of connective tissue as are found on the surface of the different organs, the surface which is turned towards the interior of a cavity being covered with a single layer of tessellated epithelium. These cavities or sacs communicate with each other by means of microscopic openings. As there are no contractile tissues in the walls of the sacs, special contractile organs acting rhythmically or lymph-hearts are superadded. A very visible one in the frog is close to the sacrum, and pumps the lymph into the sciatic vein; another propels it into the jugular. They are chiefly composed of transversely striated short muscular laminæ.

BIBL. Kölliker, *Mik. Anat.* ii.; Todd & Bowman, *Phys. Anat.* ii.; Lane, in Todd's *Cycl. Anat. & Phys.*; Brücke, *Sitz. u. Denks. d. Wien. Akad.* 1852–1855; His, *Zeit. f. wiss. Zool.* xi., xii., xiii.; Frey, *Hand. d. Hist.* 1867; Oedmanssen, *Virch. Arch.* xxviii.; Recklinghausen, *Lymphg.* Berlin, 1862, and *Lymph. Syst. in Stricker, Hum. & Comp. Hist.* vi. *Syd. Soc.*; E. Klein, *Anat. of Lymph. Syst.* i. 1873.

LYNCE'US, Müller.—A genus of Lynceidæ (Entomostraca). It comprehends 10 genera, which it has absorbed.

Char. Head projecting in a hood-like shape over the bases of the anterior and posterior antennæ. Eye accompanied by a secondary spot. Posterior antennæ two-branched and three-jointed. Six pairs of feet. Abdomen capable of being folded upwards upon the thorax, terminating in two strong claws. Intestine forming two convolutions. Anal opening on superior margin of abdomen, and at some distance from its extremity.

BIBL. Norman and Brady, *Monogr. Nat. Hist. Tr. North.*

LYNGBYA, Ag.—A genus of Oscillatoriaceæ (Confervoid Algæ), related to *Calothrix* and *Oscillatoria*, distinguished from the former by its stratified habit, from the latter by the long flexile but not oscillating filaments. It contains both freshwater and marine species. *L. muralis* (Pl. 4. fig. 10) grows in damp places and in water. The specific characters are not satisfactory; but we have found what we take to be *L. stagnina*, Kütz. Tab. Phyc. i. pl. 87. fig. 5, and *L. concinnata*, Kütz. *l. c.* pl. 89. fig. 5, in fresh water. *L. speciosa*, *Carmichaelii*, and *ferruginea*, marine species, are figured in Engl. Bot. Supp. Nos. 2926–27 *a* and *b*.

These plants appear to break up into lenticular gonidia; but their reproduction, like that of *Oscillatoria*, is very obscure.

Braxton Hicks has stated that *L. muralis*, a *Schizogonium*, and a *Prasiola* are all different stages of the same organism, and has noticed the segmentation of their gonidia into Palmelloid cells.

BIBL. Hassall, *Brit. Fr. Alg.* p. 219, pls. 59, 60, 72; Harvey, *Brit. Mar. Alg.* p. 225, pl. 26 E.; Kütz. *Spec. Alg.* p. 279; *Tab. Phyc.* i. pl. 86–90; Rabenh. *Fl. Eur. Alg.* ii. 135; B. Hicks, *Qu. Mic. Jn.* 1861.

LYSIGONIUM. See MELOSIRA.

M.

MACERATION.—The soaking of objects in various menstrua, for the purpose of causing decomposition and solution of portions of structure which are more readily attacked, is an operation frequently had recourse to in the anatomy both of animals and plants. In addition to water, cold and hot, a number of stronger agents are often employed, chiefly oxidizing substances, such as NITRIC ACID, the same combined with chlorate of potash, &c. Ammonio-

oxide of copper dissolves delicate cellulose rapidly, and does not so soon attack woody fibre, &c. See TISSUES.

MACROBIO'TUS, Schultze.—A genus of Arachnida, of the order Tardigrada, and family Arctisca.

Char. Head not furnished with appendages; mouth terminated by a sucker, without palps; skin soft, with irregular rugæ.

1. *M. Hufelandii* (Pl. 41. fig. 8). Body cylindrical, colourless; head rounded in front, with minute coloured eye-spots; sucker, pharyngeal tube, and styles well developed; œsophageal bulb supported by a solid frame-work of jointed pieces; legs equal; claws two, bifid, the point of each again bifid; movement tolerably quick; size 1-85 to 1-35″.

The most common species; found upon mosses growing on walls, stones, at the foot of trees, &c.

2. *M. Oberhäuseri.* Dark brown; colour distributed unsymmetrically in spots, and forming five longitudinal bands; no eye-spots; claws three,—one simple, terminal, and forming a short filament—the two others hooked, the interior one double or bifid, the posterior simple; movement very active; length 1-100 to 1-85″.

3. *M. ursellus.* Claws three, none filamentous.

4. *M. Dujardinii.* Claws two, bifid.

BIBL. Doyère, *Ann. des Sc. Nat.* 2 sér. xiv., xvii. and xviii.; Dujardin, *ibid.* x.

MACROCY'PRIS, Brady.—An Ostracode, allied to *Bairdia*, among the *Cypridæ*, with long, smooth, pointed valves, and characterized by short setæ on the upper antennæ and rudimentary postabdominal rami. Living in the North Sea (*M. minna*, Baird); fossil in the Chalk (*M. siliqua*, Jones).

BIBL. G. S. Brady, *Tr. Lin. Soc.* xxvi. 391.

MACROGONIDIA.—A name applied by the Germans to the larger form of ciliated zoospore found in many Confervoid Algæ, associated with a form much smaller, distinguished as MICROGONIDIA.

The number of ciliated zoospores within a sac which are discharged from *Pediastrum* are aggregated together as a macrogonidium; and the segmenting dark green bodies included in the spheres of *Volvox* escape also as macrogonidia. See ZOOSPORES, and HYDRODICTYON (p. 389).

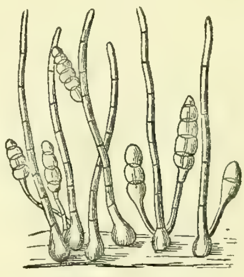
MACROSPORES, or MEGASPORES. See SPORES.

MAC'ROSPO'RIUM, Fr.—A supposed genus of Dematiei (Hyphomycetous Fungi), growing upon decaying vegetable matters, corresponding to *Septosporium*, Corda, and *Helmisporium*, Duby. Several species are British. *M. Cheiranthi*, Fr., common on wallflowers and stocks; *M. Brassicæ*, Berk., on cabbage-leaves; *M. sarcinula*, on gourds; and *M. concinnum*, on rotting decorticated willow twigs. We have found one species among the OIDIUM of the vine-fungus.

Tulasne asserts that they are stylosporous fruits of a Sphæriaceous genus. The spores of different species of *Macrosporium* were a very prominent feature in the organisms observed in deposits from the air at Calcutta.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 339; *Ann. Nat. Hist.* i. p. 261, pl. 8. fig. 10, vi. p. 435, pl. 12. fig. 21; Fries, *Summa Veget.* p. 501; *Syst. Mycol.* iii. p. 274; Corda, *Icones Fung.* i. pp. 175, 176, 188; Tulasne, *Ann. des Sc. Nat.* 4 sér. v. p. 109; Cunningham, *Mic. Exam. of Air, Calcutta*, 1873.

Fig. 440.



Macrosporium bulbotrichum.
Magnified 200 diams.

MACRO'THRIX, Baird.—A genus of Entomostraca, of the order Cladocera and family Daphniadæ.

Char. Five pair of legs; beak directed forwards; superior antennæ of considerable size, one-jointed, and pendulous from the beak; inferior antennæ two-branched, posterior branch four-, anterior three-jointed, and with a very long filament arising from the end of the first joint; a black spot at the root of the superior antennæ.

1. *M. laticornis* (Pl. 14. fig. 25). Shell oval, smooth, anterior margin strongly ciliated; eye areolar.

Found in ponds.

2. *M. roseus.* Eye without an areola; superior antennæ longer and more slender than in the above.

Probably a variety of the last. Found in Scotland.

BIBL. Baird, *Brit. Entomostr.* p. 103; Norman and Brady, *Monog. Nat. Hist. Trans. Northum.*

MADOTHE'CA, Dumortier (*Jungermannia*, L.).—A genus of Jungermannieæ (Hepaticæ), containing two British species:—one, *M. platyphylla* (fig. 441), common on walls, rocks, and trees; the other, *M. lævigata*, found on alpine rocks. The sporange is borne on a short stalk, globose, and bursts by four convex valves, from which the elaters are quite free. The globose persistent epigone is seen in the figure inside the two-lipped perigone.

Fig. 441.

Madotheca platyphylla. Magn. 5 diams.

BIBL. Endl. *Gen. Plant. Suppl.* i. p. 1341; Hooker, *Brit. Flora*, ii. p. 125, *Brit. Jungermann.* pls. 35, 40, and Supp. pl. 3; Ekart, *Synops. Jungermann.* p. 52, pl. 3. fig. 24, pl. 6. fig. 44.

MAGNESIA, SALTS OF.

Ammonio-phosphate of magnesia or triple phosphate. This salt is frequently met with in animal secretions which have undergone decomposition, also in calculi. The most common forms are prismatic, and figured in the group *a*, *b*, Pl. 9. fig. 1; but their varieties are endless. Those of the above group are frequent in decomposing urine, blood, fæces, &c. Those in group *c* are occasional in urine. Those of group *d* are found in the contents of the vesiculæ seminales. The forms *e* and *f* are rare. Fig. 2 *a*, *b*, represents the so-called penniform crystals, or rather groups of crystals (prisms) occasionally found in urine. Fig. 3 represents the stellate form, occasionally found in urine; sometimes the minute and imperfectly formed crystals of fig. 4 are met with in the same liquid.

The crystals belong to the rhombic system. The prismatic crystals were formerly regarded as consisting of a neutral, and the feathery of a bibasic salt; but the composition of the two is the same, and the variation in form depends upon the conditions under which they are produced.

The prismatic forms may be prepared by allowing urine to decompose spontaneously, or by diluting this secretion with water and gradually stirring-in very dilute solution of ammonia in small quantities at a time; the penniform crystals by adding excess of solution of ammonia to very dilute solutions of the phosphate of ammonia and sulphate of magnesia; and the feathery forms by adding excess of ammonia to urine. The prismatic crystals form a beautiful polarizing object.

Sulphate of magnesia (Epsom salt). When crystallized upon a slide from an aqueous solution, the prisms of this salt, mounted in balsam, form an interesting polarizing object; they are also analytic.

Borate of magnesia fused in a bead before the blowpipe is a beautiful object (Sorby).

Urate of magnesia. See URIC ACID.

BIBL. That of CHEMISTRY, ANIMAL, and *Phil. Mag.* 1852, iii. p. 373; Davies, *Qu. Mic. Jn.* 1865. 206.

MAGNIFYING POWER. See MEASUREMENT.

MAGOSPHÆRA, Haeckel.—A genus of Catallacta (Protista). See PROTISTA.

BIBL. Haeckel, *Biol. Stud. Jenai. Zeit.* h. 1; *Qu. M. J.* xi. n. s. 64; Carter, *M. M. Jn.* 1871. 236.

MAHOGANY.—The wood of various species of *Swietenia* (Nat. Ord. Cedrelaceæ). Cross sections of this well-known wood form good objects for showing the structure of WOOD with low power.

MAIZE.—Indian corn, *Zea Mays*, L.—One of the family of Grasses producing seeds used as corn. The seeds, or rather caryopses, are remarkably firm, being of a horny texture in the outer part of the substance, while the central mass is more or less brittle and soft. The solidity of the grain results from the outer cells of the albumen being densely filled with starch-grains (Pl. 37. fig. 3), which, by pressure, assume a parenchymatous form and cohere together firmly. In the centre they are loosely packed in the cells, and then are of rounded forms (figs. 5 & 6). Figs. 1 to 4 represent successive stages of development of the starch-grains in the protoplasmic mass originally filling the cells, but finally almost wholly displaced. See STARCH.

MALLO'MONAS, Perty.—A genus of Infusoria, whose position in the classification is doubtful.

Char. Body oval, elliptic or discoid, with brown or greenish contents; surface covered with long motionless hairs; a single filament anteriorly double the length of the body.

BIBL. Pritchard, *Infus.* p. 501.

MALPIGHIAN BODIES. See KIDNEY.

MANDIOC or MANIHOT. See CASSAVA.

MANILLA HEMP.—One of the most delicate of vegetable fibres used for textile fabrics, yielded by the liber of the fibro-vascular bundles of *Musa textilis*, a kind of banana common in the Philippine Islands (Pl. 21. fig. 7). It is manufactured into "Manilla handkerchiefs" and "Manilla scarfs," consisting of a delicate muslin. These are often erroneously stated to be made of the fibre of some kind of Pineapple. See TEXTILE SUBSTANCES.

BIBL. *Hooker's Journal of Botany*, vol. i. 28. 1849.

MARANTACEÆ.—A family of Monocotyledonous Flowering plants, to which belong the true West-Indian arrow-root plants (see ARROW ROOT), and the Tous-les-mois plants, species of CANNA. These substances consist of the starch (Pl. 37. figs. 18, 25, & 26) obtained from the tuberous rhizomes of the plants (see STARCH).

MARAS'MIUS, Fr.—A genus of Agaricini (Hymenomycetous Fungi), distinguished from *Agaricus* by its tough substance, which easily dries, and the thick obtuse gills. The species are extremely numerous, especially in tropical countries. *M. oreades*, which grows in what are commonly called Fairy rings, is one of the very best of our esculent Fungi. 28 species occur in this country.

BIBL. Grev. *Sc. Crypt. Fl.* t. 323; Berk. *Outl.* t. xiv. f. 5; Cooke, *Handb.* p. 233.

MARATTIA, Swartz.—The typical ge-

Fig. 442.

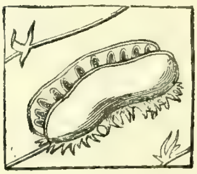


Fig. 443.

Marattia.

Fig. 442. Side view of a sorus.
Fig. 443. Indusium with the sorus removed.

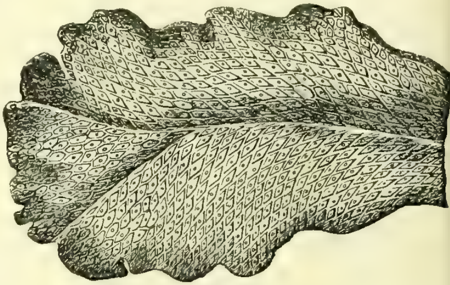
Magnified 12 diams.

nus of Marattiaceous Ferns. Exotic (figs. 442 & 443).

MARATTIA'CEÆ.—A family of Ferns, approaching the Polypodiaceæ in general habit, but more resembling the Ophioglossaceæ in their sporanges, which are destitute of an annulus, and often so fused together as to look like a multilocular sac.

MARCHAN'TIA, Micheli.—A genus of Marchantieæ (Hepaticæ), Liverworts. The most common species is *M. polymorpha*. It is a little plant, not uncommon upon the earth of damp shady courtyards, the borders of springs, &c., extending itself in bright-green thin lamellæ of irregular lobed outline, attached to the soil by radical hairs arising

Fig. 444.



Marchantia polymorpha.
Lobe of a frond.
Magnified 10 diameters.

on the lower surface. The frond presents an upper and lower epidermis, with an intermediate parenchyma; and the lobes are traversed by a kind of midrib. The upper surface is marked by raised lines which cross each other very regularly, leaving between them lozenge-shaped spaces (fig. 444), in the centre of each of which occurs a stoma, leading to an intercellular space in the parenchyma. The stomata of *Marchantia* are circular, and consist of sixteen cells, arranged so as to form four rings, one upon another, each ring being composed of four cells; they may be best explained by comparing them with a chimney composed of four courses of bricks, each consisting of four bricks laid together to enclose a square. The parenchyma is composed of several layers of cells, which contain much chlorophyll. The inferior epidermis is clothed by radical hairs, which exhibit a remarkable spiral marking, arising from the projection of a spirally deposited secondary layer in the interior of the tube.

The fronds do not readily develop sporanges in shady places; but when exposed to the light, they are produced at the ends of the ribs, at the base of the terminal notches of the lobes. The male structures are produced on different plants from the female; but both are borne on peculiar stalked receptacles. The first appearance of one of these receptacles is as a little green papilla surrounded by reddish scales, at the end of one of the principal ribs. As it enlarges, it

pushes its way through the scales; and the rib on which it is borne elongates to form a pedicel, on which it is raised up perpendicularly above the surface of the frond,

Fig. 445.

Marchantia polymorpha.
Plant with antheridial receptacles (male).
Nat. size.

ultimately acquiring the form of an expanded cap. In the male receptacles it has a sinuate margin (fig. 445); and in the female the border is developed into eight or nine thick cylindrical lobes (fig. 446).

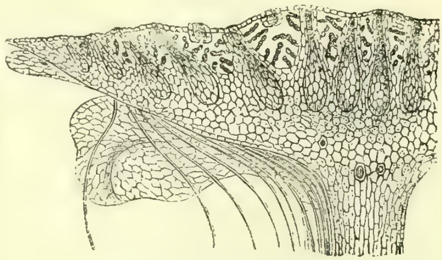
Fig. 446.

Marchantia polymorpha.
Plant with fertile receptacles (female).
Nat. size.

The male receptacle is concave above, with papillæ consisting of the mouths of flask-shaped cavities, in each of which is formed an *antheridium* (fig. 447). These antheridia are oval cellular bodies lodged in the expansion of the cavity, with a long neck projecting upward through the mouth of the flask-shaped excavation. The cells of the interior of the lower part of the antheridia produce spermatozoids (Pl. 32. fig. 32). The lower surface of the receptacle is clothed by membranous processes and hairs.

The female receptacles are somewhat convex above; and on the under surface of the base of each lobe are found delicate membranous processes with toothed margins. The membranes of each two adjoin-

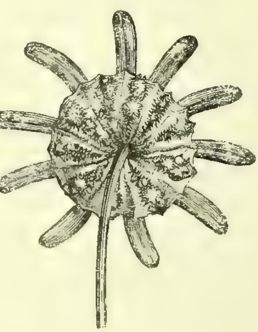
Fig. 447.



Marchantia polymorpha.
Section through an antheridial receptacle, showing flask-shaped cavities containing the antheridia.
Magnified 25 diameters.

ing lobes form a *perichætium* (fig. 448) alternating with the lobes, concealing between them the *archegonia*, which are attached by their bases, and have their mouths pointing downwards. The archegones of

Fig. 448.

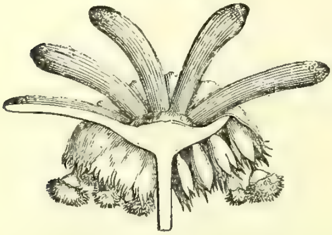


Marchantia polymorpha.
A sporangial receptacle seen from below.
Magnified 5 diameters.

Marchantia are flask-shaped sacs with a long neck (figs. 325–327, p. 375), containing in their cavity a cell (germ-cell), which after fertilization becomes developed into an oval cellular body, the young *sporangium*. In the course of the development of this, it soon fills the cavity of the archegone, which then begins to grow with it, and subsequently forms a loose sac around it—the *epigonium*—finally ruptured at the point, so

as to exhibit four or five teeth or valves, which become recurved (fig. 449). Meanwhile another envelope grows up around the epigone, appearing at first as a mere ring surrounding it (figs. 325–327, p. 375), but ultimately rising up so as to enclose it, remaining open however at the summit; this is the *perigonium.* In its young stages the sporange is a mere oval mass of polygonal cells; but a distinction may soon be detected between a cortical or peripheral layer and the internal mass. The cells of the former remain firmly united into a membrane forming the wall of the sporange. These cells grow so as to assume an elongated form, and when mature exhibit internally a spiral-fibrous secondary deposit (Pl. 32. fig. 35), analogous to that of the cells of the anthers of Flowering plants. The cells of the internal mass present at an early period the appearance of a large number of filaments radiating from the centre of the sporange to the wall. These soon become free from each other; and it may then be perceived that some are of very slender diameter, and others three or four times as thick. The slender ones are developed at once into the long *elaters* (Pl. 32. fig. 36) characteristic of this genus, containing a double spiral fibre, the two fibres, however, coalescing into one at the ends (fig. 37). The thicker filaments become subdivided by cross partitions, and break up into squarish free cells, which are the parent cells of the *spores*, four of which are produced in each (Pl. 38. figs. 10–13). The spores of *M. polymorpha* have but a single coat; and their contents are bright yellow when mature. When they germinate, the contents are converted into chlorophyll; and the growth commences by the production of a tubular process from one side of the spore.

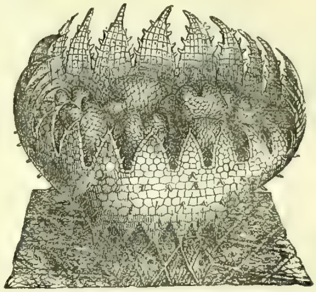
Fig. 449.



Marchantia polymorpha.
Vertical section of Fig. 488, showing sporanges *in situ*, bursting to discharge the spores and elaters.
Magnified 10 diameters.

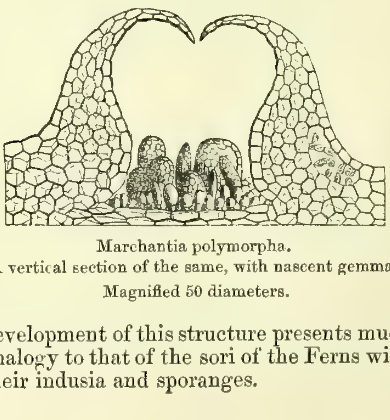
It has been mentioned that *M. polymorpha* does not fruit freely in the shade. Under these circumstances it produces *gemmæ*, consisting of little, compressed, oblong masses of cells, of green colour, capable of reproducing the plant. These are found, when mature, in elegant cup-like structures, with toothed borders, sessile on the upper face of the frond (figs. 446, 450). The cup seems to be formed by a development of the superior epidermis, which is raised up and finally bursts and spreads out, laying bare the gemmæ, produced from the internal parenchyma. The gemmæ consist at first of a single cell, which divides so as to present an upper and a lower (stalk-) cell; the upper multiplies until it becomes a cellular mass (fig. 451). The development of this structure presents much analogy to that of the sori of the Ferns with their indusia and sporanges.

Fig. 450.



Marchantia polymorpha.
A collection of gemmæ in their involucre.
Magnified 25 diameters.

Fig. 451.



Marchantia polymorpha.
A vertical section of the same, with nascent gemmæ.
Magnified 50 diameters.

The *Marchantiæ* also increase by *innovations*, or lobes of the frond becoming detached from those on which they originate.

These plants form most interesting objects of microscopic investigation, in all parts of their structure.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 105; *Engl. Botany*, pl. 110; Mirbel, *Rech. anat. et physiol. sur le Marchantia, Mémoires Acad. Roy. Paris*, xiii. pp. 337, 375; Nägeli, *Wurzelhaare der Marchantia, Linnæa*, xvi. 1842; Henfrey, *Dev. of Spores and Elaters of Marchantia, Linn. Trans.* xx. p. 103, pl. 11; Thuret, *Rech. sur les Anthéridies, Ann. des Sc. Nat.* 3 sér. xvi. p. 72, pl. 12. figs. 1–5; Gottsche, *Bot. Zeitung*, 1858, *Suppl.*

MARCHANTI'EÆ.—A family of Liverworts or Hepaticæ, having broadish, lobed, thalloid fronds, from the bifurcations of which arise stalked receptacles, bearing a number of variously arranged sporanges containing spores mingled with elaters, but destitute of a columella. *British Genera*:—1. *Marchantia*; 2. *Fegatella*; 3. *Reboullia*; 4. *Lunularia*. See Hepaticæ.

MARGARIC ACID and MARGARINE.—The former general ingredient of the fatty matters of both the animal and vegetable kingdom, when crystallized from hot alcohol, forms minute needles, either isolated or in groups (Pl. 7. fig. 16 *a*). The crystals differ from those of stearic acid, which form lanceolate single or aggregated plates (Pl. 7. fig. 16).

Margarine crystallizes from a hot alcoholic solution in fine needles, mostly grouped or branched, sometimes surrounding globules of oleine, or forming bulb-like aggregations of needles (Pl. 7. fig. 15). It is sometimes found crystallized within the cells of fatty tissue (Pl. 7. fig. 15 *a*).

Bibl. That of Chemistry.

MARGINULI'NA, D'Orb.—A Nodosarine Foraminifer, elongate, equilateral, often curved or spiral in its earlier portion; chambers globular or compressed; orifice rounded, marginal. *M. raphanus* (Pl. 18. figs. 30–32) is a *Nodosaria* with an eccentric aperture; and by gradual modifications *Marginulina* passes into *Cristellaria*, with which Williamson unites it.

Common in existing seas; and fossil from the Trias upwards.

Bibl. Williamson, *Rec. Foram.* 30; Morris, *Cat. Brit. Foss.* 37; Parker & Jones, *Ann. N. H.* 3. xii. 432; Carpenter, *Introd. Foram.* 163.

MARSIL'EA, L.—A genus of Marsileaceæ (Flowerless Plants), growing in mud, by a creeping rhizome, from which arise erect filiform leaf-stalks, supporting a compound four-lobed blade; at the bases of the leaf-stalks arise also stalked capsules, chambered in the interior, being divided by one perpendicular and many horizontal septa; in these chambers are found sacs (sporanges) containing the spores. As this plant is not native in this country, we do not enter very minutely into its characters, especially as in all essential respects it agrees with Pilularia.

Bibl. See Marsileaceæ.

MARSILEA'CEÆ.—A family of Flowerless plants possessing a slight leafy stem; composed of a small number of plants, of minute dimensions, but of great interest in a physiological point of view. They are all aquatics, some growing in the mud in and around ponds, others floating on the surface of stagnant waters. They all bear distinct spore-fruits or sporocarps, seated on a stalk arising from the stem. These contain sporanges or spore-sacs, differently arranged in the different genera, but agreeing in this respect, that they contain spores of two kinds, analogous to the two kinds of spore in Lycopodiaceæ, but differing in their mode of development.

Pilularia globulifera is the only British species. The small spores produce *spermatozoids*, formed in vesicles developed in chambers into which the spores become divided in germination. The large spores produce in germination a *prothallium*, somewhat like that of Lycopodiaceæ, on which is developed a single *archegonium* in *Pilularia* and *Marsilea*, and several *archegonia* in *Salvinia*. Hanstein has shown that the small spores (microspores or endospores), after escaping, become homogeneous and plastic, and contract all round their margin. The mass then becomes divided by three planes of segmentation into eight parts, and eventually into thirty-two; and on the completion of this segmentation, a cell membrane is formed around each mass. A spermatozoid is developed in each of the thirty-two cells (daughter cells), which are set free after a short time. Each spermatozoid consists of a corkscrew-like filament, which possesses a rapid whirling motion, and is beset with long cilia. The spermatozoid drills its way into the *archegonium*. The germ-cell of the *archegonium*, fertilized by the spermatozoids, becomes developed *in situ* into the new leafy plant, which was

thus formerly regarded as a product of the simple germination of the spore.

BIBL. Hofmeister, *Vergleich. Unters.* p. 103, pls. 21 & 22; W. Griffith, *on Azolla, Calcutta Journal of Nat. History*, July 1844; R. Brown, *on Azolla, Flinders's Voyage, Botany*, 612, pl. x.; Henfrey, *Trans. Brit. Assoc.* 1851; *Ann. Nat. Hist.* 2 ser. ix. p. 447; Hanstein, *Monatsb. d. Akad. d. Wiss. z. Berlin*, 1864; *Ann. Nat. Hist.* 1864.

MASTIGOB'RYUM. See HERPETIUM.

MASTIGOCER'CA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eye single and cervical; tail-like foot styliform; carapace prismatic, with a dorsal crest.

M. carinata (Pl. 34. fig. 46, side view). Foot as long as the body; aquatic; entire length 1-72″.

BIBL. Ehrenberg, *Infus.* p. 460.

MASTIGOCLA'DUS, Cohn.—A genus of multicellular, branching Algæ.

Char. The filaments are moniliform, dichotomously ramose, and are without sheaths. The secondary branches have cylindrical cells, amongst which are some elliptical in outline. Forming a fleshy, spongy layer.

BIBL. Rabenh. *Fl. Eur. Alg.* ii. p. 26.

MASTIGONE'MA, Schwabe.—A genus of multicellular Algæ.

Char. Filaments aggregated or cæspitose and articulated; elongate, with thin ends; sheathed, and the apex of the sheath open. *M. plana*, an Irish and Scottish species.

BIBL. Rabenh. *Fl. Eur. Alg.* ii. p. 226.

MASTIGO'THRIX, Kütz.—A genus of multicellular Algæ.

Char. Filament single, bent, flagelliform, ending in a produced hyaline process, sheathed and articulated, with a persistent cellular base. Parasitic amongst the fronds of Algæ.

BIBL. Rabenhorst, *Fl. Eur. Alg.* ii. p. 225; Kütz. *Phycol. Gener.* p. 232.

MASTIGOTRICH'EÆ.—A subfamily of Rivulariaceæ (multicellular Algæ) with an indefinitely expanded thallus, which is often hard and shell-like.

MASTOGLO'IA, Thwaites.—A genus of Diatomaceæ.

Distinguished by the *Navicula*-like frustules, the hoops of which are furnished with loculi, immersed in a mammillate frond.

Five British species, marine and aquatic.

M. lanceolata (Pl. 42. fig. 26). Valves lanceolate, elliptical, ends acute; loculi 8–30; in brackish water.

M. Danseii=*Dickieia Danseii*, Thw.

BIBL. Smith, *Brit. Diat.* ii. 63; Thwaites, *ibid.* and *Ann. Nat. Hist.* 1848, i. 171; Carpenter, *Micros.* 309.

MASTOGO'NIA, Ehr.—A doubtful genus of fossil Diatomaceæ.

Char. Frustules single; valves dissimilar, angular, mammiform, orbicular at the base, free from umbilical processes, not cellular, angles radiating.

The (eight) species are interesting from the structure of the two valves of the frustules differing. Thus in one, *M. crux* (Pl. 43. fig. 23 *a*) the angles and rays are four in one valve, but seven in the other; in *M. actinoptychus* (Pl. 43. fig. 23 *b*) the angles and rays are nine in one valve, and thirteen in the other, and so on. Diameter from 1-1600 to 1-360″.

M. hexagona (Pl. 43. fig. 25).

BIBL. Ehrenb. *Ber. der Berl. Akad.* 1844; Kütz. *Sp. Alg.* p. 25.

MATO'NIA, R. Brown.—A genus of Aspidieæ (Polypodioid Ferns) with a curious stalked and imbricate basin-like indusium (figs. 452–454). Exotic.

Fig. 452.

Fig. 453.

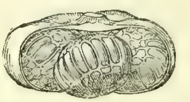


Fig. 454.

Matonia pectinata.

Fig. 452. Part of a fertile pinna. Magn. 3 diams.

Fig. 453. Indusium opened at the side, showing thecæ *in situ*. Magn. 25 diams.

Fig. 454. The same with the thecæ removed. Magn. 25 diams.

MAURANDYA.—A genus of Scrophulariaceæ (Dicotyledonous Flowering Plants), the testa of the seed of which is composed of cells with spiral-fibrous deposits, forming an elegant microscopic object.

MEASUREMENT and MEASURES.—In this article we shall consider the method of measuring the magnifying power of a microscope, of ascertaining the dimensions of objects, and shall give a sketch of the standard measures in which the dimensions of objects are expressed.

Measurement of the magnifying power of a microscope.—The apparent size which an object will appear to possess under a microscope will vary of course according to the power of the object-glass and of the eyepiece used, and the length of the body of the microscope; and it is a good plan to determine the measurements once for all in the case of the various object-glasses and eyepieces, keeping them written upon a card, so that they may be readily accessible.

The apparatus requisite consists of a micrometer-slide graduated into thousandths of an inch, each tenth division being marked by a longer line; or two separate slides, one graduated into thousandths, the other into hundredths of an inch; and an ivory scale, graduated into inches, tenths, and hundredths.

The simplest method is that by double sight, as it is called. The micrometer-slide is placed upon the stage, the lines brought into focus, and the image of one of the interspaces, as seen upon the stage with the open eye not used in looking through the microscope, is measured with compasses. By then dividing the measure of the image of the space by the known measure of the unmagnified space, the quotient is the required magnifying power. Thus, if the space on the micrometer scale is equal to the 1-100th of an inch, and the image of the magnified space corresponds to 5-10ths of an inch, the space is magnified 50 times: $\frac{5}{10} \div \frac{1}{100} = 50$.

The same result may be obtained with the aid of the camera lucida, by placing the microscope horizontally, and its axis at a distance from the table equal to the distance between the focus of the eyepiece and the stage; the breadth of the image of a division is then measured as before; and this is the best and most certain method.

A most important point in relation to this subject is, that the joint of the microscope shall be furnished with a stop or pin (INTRODUCTION, p. xiii), by which the body may be placed horizontally at once, so that all objects which are drawn under the same object-glass and eyepiece may be magnified to the same extent, the degree being determined by the second of the above methods.

The obvious use of being acquainted with the magnifying power of a microscope is that objects under examination may be viewed by the same power as that with which figures of them have been made, so that the structure or appearance of the objects in the two cases may be compared. We have elsewhere stated the importance of expressing the magnifying power with which figures of objects have been drawn (INTRODUCTION, p. xl).

In the above estimation of the magnifying power, one dimension only is taken into account, viz. the breadth or diameter; and this is the ordinary manner in which the magnifying power is taken; objects are then said to be magnified so many diameters, or so many times linear.

Measurement of the size of objects.—This is effected with the aid of a slide-micrometer passed through two slits in the eyepiece above the stop, and at the focus of the upper glass of the eyepiece. The breadth of the spaces between the lines must be such as to give an even and minute fraction of an inch. The value of the spaces will vary with the power of the object-glass and eyepiece; so that it must be determined in each case, and recorded. For measuring small objects, the breadth of the spaces in the eyepiece micrometer may be such that twenty of them correspond to 1-1000th of an inch in the stage-micrometer slide, so that the value of each division will be the 1-20,000th part of an inch. It is seldom that we have to measure objects so small as this; but the small size is of great advantage, because in most cases it will happen that the margins of the objects will coincide exactly with some of the lines, whereby the chance of error in computation will be avoided. For larger objects, the spaces of the eyepiece micrometer may be coarser.

The method of measuring scarcely requires further explanation. Supposing, however, that the divisions of the stage-micrometer are equal to 1-1000th of an inch, and those of the eyepiece-micrometer equal to 1-20,000th of an inch (*i. e.* twenty of them cover one space in the former), an object brought into focus and covering five of the spaces of the eyepiece micrometer, will be 1-4000th of an inch in diameter; and so for other dimensions. When the objects are large, the compasses and the ivory scale

will suffice for their measurement; but sometimes this may be conveniently done under a low power, for the 1-100ths of an inch are not very clearly discernible to all eyes.

In measuring objects, they must be covered with thin glass, and not immersed in too much liquid.

It is a matter of great difficulty, under high powers, to adjust accurately the divisions of the eyepiece micrometer to those of the stage-micrometer, or to the margins of objects, by means of the movable stage; a very ingenious apparatus has been contrived by Mr. Jackson to overcome the difficulty. It consists of a little brass frame, in which the eyepiece-micrometer slides from side to side, the motion being communicated by the end of a screw working against one end of the slide, and resisted at the other by a spring; and as the magnifying power with which the divisions of the eyepiece micrometer are viewed is small, the adjustment is easily and accurately effected.

Hartnack's diagonal scale is very useful; and very minute investigations and measurements may be taken with it and with Jackson's eyepiece-micrometer to 1-100,000th of an inch.

Other micrometers, as the 'cobweb-micrometer,' are made; but as they are very expensive and not necessary, we shall pass them over.

Some authors express the measurement of objects by means of a ruled scale appended to the figures or plates of them, the scale consisting of divisions of a stage-micrometer of known value traced off under the same power as the objects themselves; or sometimes the divisions are ruled over the figures. These methods are very objectionable, because the size of the objects cannot be ascertained without measuring with compasses and calculation, which is almost as bad as the size being omitted altogether.

Whenever figures of objects are given, the magnifying power with which they are drawn should always be expressed in numbers near the figures.

Measures.—The measures in which the dimensions of objects are expressed should consist of parts of an English inch, and not of a line. On the continent, and also very generally in this country, fractions of a millimetre are used. When fractions of a millimetre are adopted, this is usually denoted by the addition of ^{mm} to the figure or figures.

The following data will be found useful in reducing the foreign to the English measures:—

A millimetre = 0·0393707 English inch; or (roughly) rather less than 1-25th of an English inch.

A centimetre = 0·393707 Eng. inch; or (roughly) rather more than 1-3rd Eng. inch.

A Paris line = 0·088815 Eng. inch; or rather more than 1-11th Eng. inch, to which vulgar fraction it is nearest.

To convert a foreign into the English measure, the former must be multiplied by its unit value; thus, $0·25^{mm}$ (millimetre) × 0·0393707 = 0·009842675 Engl. inch. But in most cases a few decimal places only need be observed. In this way, however, we get a rather long sum, which may be avoided by the use of the following Table,

Table for conversion of foreign into English measures.

	Millimetres into English inches.	Old Paris lines into English inches.	Prussian lines into English inches.
1	·039370	·088815	·085817
2	·078741	·177630	·171633
3	·118112	·266445	·25745
4	·157483	·355260	·343267
5	·196853	·444075	·429083
6	·236224	·532890	·51490
7	·275595	·621705	·600717
8	·314966	·710520	·686532
9	·354337	·799335	·77235

in which the numbers in the first (or left-hand) column correspond to the denominations expressed in the uppermost (head) line of the three broader columns, while the fractions opposite these numbers denote their values in parts of the denominations of the lowermost (head) line. Thus, 1^{mm} = 0·039370 Eng. inch; 3^{mm} = 0·118112; 2 Prussian lines = 0·171633 Eng. inch, and so on. In using this Table, the decimal fraction to be converted into parts of an English inch must be broken up into its decimal parts, and each valued separately from the Table; thus, to convert $0·75^{mm}$ into a fraction of an English inch—

$$\left.\begin{array}{l} 0·7^{mm} = 0·0275595 \\ 0·05^{mm} = 0·00196853 \end{array}\right\} \text{(by the Table).}$$

$$0·75^{mm} = 0·02952803 \text{ Eng. inch.}$$

The only circumstance which requires

attention in the use of this Table is the position of the decimal point. Thus, in the above measure of 0·75mm, which, when broken up, makes 0·7mm and 0·05mm, if the first value (0·7) had been 7·0, the value in Eng. inch would have been, according to the Table, 0·275595 Eng. inch; but this is 10 times too much, or =7 whole millimetres; hence the shifting of the decimal point, and so on. To express the mode of proceeding by rule,—the decimal point in the fraction of an English inch given by the Table should be shifted to the left, and as many ciphers added as there are decimal places in the foreign measure.

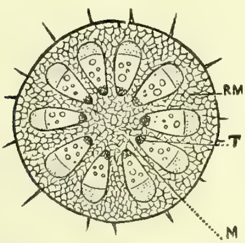
Throughout this work the foot and inch and their fractional parts are expressed for brevity by placing respectively one or two acute accents on their right side; thus, one foot is denoted by 1′, and one inch by 1″, $\frac{1}{10}$th of an inch by 1-10″, &c.

MEDUL'LA OBLONGA'TA.—A portion of the nervous system which is bounded below by the spinal cord, and which is connected above with the mesocephale.

Bibl. of its microscopic anatomy. Stilling, *Ueber d. Text. d. Med. obl.* 1842; Lenhossek, *Denks. d. k. Acad. d. wiss. Wien*, 1855; Dean, *On Medulla &c.*, Washington, 1864; L. Clarke, *Phil. Trans. Roy. Soc.* 1868; Meynert, *in Stricker's Human & Comp. Hist. tr. Power*, 1872.

MEDUL'LA of Plants.—The name applied by the older authors to the pith of

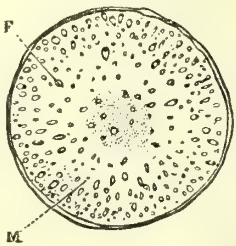
Fig. 455.



Horizontal section of a yearling shoot of a Dicotyledon. M, medulla; RM, medullary rays; T, medullary sheath. Magnified 25 diameters.

Dicotyledons (fig. 455 M), from a supposed analogy with the *medulla spinalis* of animals. It affords very excellent subjects for preparing sections of regular parenchymatous tissues, as in the elder and in the tall annual stems of many of the larger perennial herbaceous plants. It sometimes becomes curiously chambered as it grows older, as in the walnut and the jasmine; very frequently, however, it decays away after a time, leaving the centre of the stem hollow; this same hollow condition occurs early in fistular stems, such as those of the Umbelliferæ, from the pith being torn up by rapid expansion of the wood. The Monocotyledons do not generally possess a definite pith; the cellular mass, in which the isolated Fibro-vascular Bundles are imbedded, answers to a diffused pith, or rather to the pith and medullary rays collectively. It may be seen well in sections of the flowering stem of lilies (fig. 456 M).

Fig. 456.



Horizontal section of a flowering stem of a lily. M, medulla; F, fibro-vascular bundles.

Magnified 5 diameters.

A more definite medulla occurs in the stem (and in the leaves) of the rushes and sedges, where also the cells are often of most elegant radiating forms, leaving large air-canals between them (Pl. 38. fig. 18). The pith of a Dicotyledonous stem loses itself gradually in the terminal bud, where it is confounded with the nascent wood and cortical layers. In this stage its cells possess an active vitality, which, however, is soon lost.

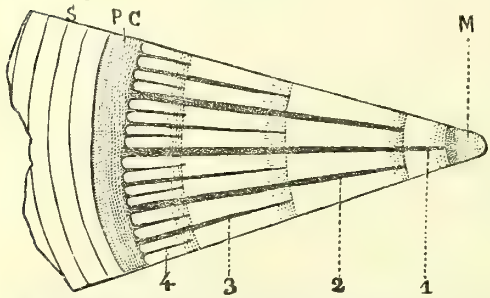
Bibl. General Works on *Structural Botany*.

MED'ULLARY CANCER. See Tumors.

MED'ULLARY RAYS.—The processes of cellular tissue extending out from the pith between the fibro-vascular bundles of a Dicotyledonous stem in the first year of growth (fig. 455 R M), together with additional interposed rays formed between the older in each succeeding annual layer of wood (fig. 457 1, 2, 3, 4). The tissue of these rays generally becomes much compressed during growth; but their size and the degree of development differ much in different cases. In radial sections of Dico-

tyledonous wood they often appear distinctly to the naked eye, from the direction of their cells being different from that of the woody fibre, and therefore reflecting light dif-

Fig. 457.



Section of a four years' old shoot of the Cork oak. M, pith; 1, 2, 3, 4, medullary rays of successive years; P. C, liber layers; S, cork layers.
Magnified 20 diameters.

ferently; this causes the "silver grain" as it is called of oak-panels, &c.; in tangental sections of the trunk, the ends of the medullary rays usually appear as short, more or less regular, narrow streaks.

MED'ULLARY SHEATH.—The earliest layer of fibro-vascular tissue developed in a Dicotyledonous stem, consists ordinarily of spiral vessels, these forming the foundation of the wood-bundles (fig. 455 T). As the latter stand in a circle round the pith, their internal vascular layers of course form collectively a continuous cylindrical envelope to the pith; this is called the medullary sheath. It is absent in some Dicotyledonous stems, for example in the Orobanchaceæ.

MEDU'SÆ. See Acalephæ.

MEE'SIA, Hedw.—A genus of Bartramioid Mosses; one species, *M. uliginosa* (= *Bryum trichodes*), certainly British; another, *M. longiseta*, doubtful.

MEESIA'CEÆ.—A tribe of Bartramioid Mosses, containing two genera, of which there are but few British representatives. See Meesia and Paludella.

MEGALOT'ROCHA, Ehr.—A genus of Rotatoria, of the family Megalotrochæa.

Char. Eyes two, red, sometimes disappearing with age.

Rotatory organ two-lobed or horse-shoe-shaped; teeth in rows.

1. *M. albo-flavicans*, E. (Pl. 35. fig. 1). Colourless and unattached when young, yellowish and grouped in radiant clusters when old; aquatic; length of individuals 1-36''; of the clusters 1-6''.

The ova remain some time attached to the parent by a cord.

2. *M. velata*, Gosse.

Bibl. Ehr. *Infus.* p. 396; Gosse, *Ann. N. H.* 1851, viii. p. 198; Pritch. *Infus.*

MEGALOTROCHÆ'A, Ehr.—A family of Rotatoria.

Char. Neither envelope nor carapace present; rotatory organ simple, notched or sinuous at the margin.

Three genera:

Eyes none	1. *Cyphonautes.*
Eyes present	
Eye one	2. *Microcodon.*
Eyes two	3. *Megalotrocha.*

Bibl. Ehr. *Infus.* p. 394.

MEGAM'ERUS, Dugès.—A genus of Arachnida, of the order Acarina, and family Trombidina.

Char. Palpi long, free with a claw; body constricted; coxæ distant; legs ambulatory—femora, especially of the fourth pair, very large, seventh joint short; larvæ hexapod, resembling the adults.

Mandibles forcipate.

Several species. They live in damp shady places, and move rapidly.

M. celer (Pl. 2. fig. 33: *a*, labium; *b*, palp). Minute; abdomen oblong; the sides narrowed posteriorly, covered with hairs, and with three terminal setæ; labium bifid; mandibles with a movable, elongated, pointed and curved claw.

Pl. 2. fig. 33 *c*, mandible of *M. roseus.*

Bibl. Dugès, *Ann. des Sc. Nat.* 2 sér. ii. p. 50; Gervais, *Walck. Arachn.* iii. 169.

MELANÆ'MIA.—Melanæmic pigment originates chiefly in the spleen, under the influence of malaria. The pigment particles are found among the usual floating constituents of the blood; and their shape is very irregular. They are made up of yellow, brown, but most commonly of black granules, smaller than blood-corpuscles; some, however, are larger.

Bibl. Rindfleisch, *Path. Hist.* i. p. 218, *Baxter tr.*

MELANCONI'EI.—A provisional family of Coniomycetous Fungi, distinguished from Sphæronemei by the perithecium being obsolete or altogether wanting. The spores, which vary much in the different genera, are ultimately protruded in the form of tendrils or otherwise. They are all probably mere forms of Sphæriacei.

MELANCO'NIUM, Lk.—A supposed genus of Melanconiei (Coniomycetous Fungi), so called from forming a kind of black rust on branches of trees, reeds, &c. Several species have been found in Britain. The commonest is *M. bicolor*, Nees (*Didymosporium elevatum*, Br. Fl.), on twigs of birch. Fries places also *Cryptosporium vulgare* here. (See CRYPTOSPORIUM.) These plants are forms of Sphæriacei. See CONIOMYCETES.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 357; *Ann. N. H.* vi. p. 438; Fries, *Summa Veg.* p. 508; Tulasne, *Ann. d. Sc. Nat.* 4 sér. v. p. 109.

MELANOGAS'TER, Cd.—A genus of Gasteromycetous Fungi, belonging to the division Hypogæi. Two species occur in this country, under beech, Lombardy poplars, &c. *M. variegatus* is sold in the market at Bath under the name of Red Truffle, but it has none of the fine flavour of the real Truffle. *M. ambiguus* is very fetid, smelling like asafœtida.

BIBL. Tul. *Fung. Hyp.* t. 2. f. 4, 5; Berk. *Outl.* p. 293; Cooke, *Handb.* p. 356.

MELANOTHE'CA, Fée.—A genus of Lichenacei.

Char. Thallus scarcely any; apothecia verrucaroid, numerous, 3–10 or more, confluent; hymenia scarcely distinct; perithecium black; spores 8, variously internally divided. Two British species, on trees.

BIBL. Leighton, *Lich. Flora.*

MELAS'MIA, Lév.—A supposed genus of Sphæronemei (Coniomycetous Fungi), but apparently only a stylosporous form of RHYTISMA. *M. acerina* occurs on the leaves of the sycamore, forming black spots, sometimes as much as 1-2″ in diameter.

BIBL. Berk. *Ann. N. H.* 2 ser. v. p. 456; Léveillé, *Ann. des Sc. Nat.* 3 sér. v. p. 276; Fries, *Summa Veg.* p. 423.

MELASPI'LEA, Nyl. — A genus of Lichenacei.

Char. Apothecia black, superficial, arthonoid. Spores 1-septate; paraphyses distinct.

Hab. Ireland. Two species.

BIBL. Leighton, *Lich. Flora*, p. 404.

MELICER'TA, Schrank.—A genus of Rotatoria, of the family Flosculariæa.

Char. Bodies each in an isolated tubular carapace or urceolus; rotatory organ four-lobed; eyes two, at least when young.

M. ringens (Pl. 35. fig. 3; fig. 4, animal removed from the sheath; fig. 6, jaws). Carapace conical or cylindrical, brownish, composed of numerous rounded or discoidal bodies agglutinated together; body colourless. Length of carapace 1-36 to 1-24″.

Frequently found attached to water-plants, especially *Potamogeton crispus.*

BIBL. Ehr. *Infus.* p. 404; Williamson, *Micr. Journ.* 1852; Gosse, *Trans. Mic. Soc.* 1851, iii. 62.; Pritchard, *Infus.*

MELI'OLA, Fr.—A genus of Ascomycetous Fungi, belonging to the division Perisporiacei.

All the species are exotic, occurring on various leaves, and distinguished by their highly developed mycelium and large septate sporidia.

BIBL. Léveillé, *Ann. d. Sc. Nat.* 1846, v. p. 266; Mont. *Cuba Crypt.* p. 327.

MELOBE'SIA, Carter. — A genus of Algæ. The "coccospheres," according to Carter, are the sporangia of the species *M. unicellularis.*

BIBL. Carter, *Ann. N. H.* 1871, p. 184.

MELOLON'THA, Fabr. (Cock-chafer). —A genus of Coleopterous Insects, of the family Melolonthidæ.

The structure of *M. vulgaris*, the common cock-chafer, has been elaborately studied and described.

BIBL. Suckow, *Naturg. des Maikäfers*; Straus-Dürckheim, *Anat. comp. des Insect.*; Westwood, *Introd. &c.*

MELOPH'ILA, Nitzsch (*Melophagus*, Latr.).—A genus of Dipterous Insects, of the family Hippoboscidæ.

Char. Head posteriorly received in an excavation of the thorax; wings and halteres absent; last joint of the tarsus largest.

M. ovinus, the sheep-tick (Pl. 28. fig. 23). Common upon sheep. Antennæ small, sunk in an eye-like cavity of the head; eyes small, oval, resembling two groups of ocelli; setæ three, enclosed in two sheath-like, hairy, unjointed organs (labial palpi), resembling otherwise those of *Pulex*, and arising from the sides of a triangular labium. Legs robust; tarsi with two stout serrated claws, each having at its base a blunt process; accompanying the claw is an elegant feathery tarsal brush; and on the under side of the last tarsal joint is a bilobed pectinate organ.

BIBL. Lyonnet, *Rech. s. l'Anat. et les métamor.* Paris, 1832; Gurlt, *Magaz. f. d. gesam. Thier.* 1843, ix.; Westwood, *Intro. &c.*; Curtis, *Brit. Entom.* 142; Dufour, *Ann. des Sc. Nat.* 1845. iii.; Leuckart, *Fortpflanz. &c. der Pupiparen.*

MELOSI'RA, Ag. (*Gallionella*, Ehr.).—A genus of Diatomaceæ.

Char. Frustules cylindrical, discoidal

or subspherical, united into jointed filaments.

Hoops often very broad, to adapt themselves to the breadth of the new frustules. In some species a narrow projecting ridge or keel encircles the valves near their ends. Valves covered with depressions which are mostly very minute and invisible under ordinary illumination; in the side view these sometimes have a radiate arrangement. In some species the margins of the ends (side view) of the frustules have coarse and distinct radiating striæ, their nature undetermined.

This genus has been subdivided by Ehrenberg and Kützing into:—*Lysigonium*, in which the keel is present; and *Gallionella* (proper), in which this is absent. Again, by Thwaites into:—*Aulacosira*, in which the frustules are cylindrical, surrounded transversely by two furrows, with rounded (convex) ends, but no line for division; *Orthosira*, in which the frustules are exactly cylindrical (with flat ends), exhibit the transverse line of division, and have spherical or subspherical internal cavities; and *Melosira* (proper), in which the frustules are convex at the ends, and have the central line for division; including also the varieties in the reproduction (DIATOMACEÆ, p. 242).

Numerous British species.

* *Marine.*

1. *M. nummuloides*, Kg. (Pl. 13. fig. 5 *a*; *b*, a frustule more magnified). Prepared frustules colourless, a distinct keel present; valves without markings under ordinary illumination; breadth 1-1500 to 1-1200″.

This common species forms long, slightly curved chains, and, on account of the great breadth of the frustules, shows well the various stages of subdivision. The filaments are sometimes stipitate.

2. *M. Borreri*, Grev. Prepared frustules dark brown, ends rounded, entire surface punctate (ordin. illum.), no striæ nor keel present; breadth 1-850 to 1-500″.

3. *M. Dickiei* (*Orthosira Dickiei*, Thw.) (Pl. 13. fig. 15: *a*, front view; *b*, side view). Filaments short, frustules nearly colourless, ends flat, no striæ nor keel (ord. illum.), valves thickened, so as to render the cavity of the frustules rounded; breadth 1-1500 to 1-1200″.

The remarkable sporangia formed in this species (Pl. 6. fig. 9) are noticed under DIATOMACEÆ, p. 237.

** *Aquatic.*

4. *M.* (*Orthosira*) *varians* (Pl. 13. fig. 6, front view; *a*, side view). Frustules colourless, ends slightly convex and striated at the margin (ord. illum.), keel absent; breadth 1-1500 to 1-1200″. The end view of the frustules resembles that of *Cyclotella*.

Formation of sporangia shown in Pl. 6. fig. 8 *a*; *b*, sporangial frustule.

5. *M. arenaria*. Ends of frustules flat and striated at the margin (ord. illum.), the striæ appearing also in the front view; keel absent; frustules broader than long; breadth 1-660 to 1-260″.

6. *M. crenulata*, Kg. (*Aulacosira crenulata*, Thw.; *M. orichalcea*, Ralfs) (Pl. 6. fig. 7 *a* forming sporangia; *b*, *c*, sporangial frustules). Differs from the last in its less diameter, and the frustules being two or three times as long as broad; breadth 1-1400″.

BIBL. Kütz. *Bacill.* p. 52, and *Sp. Alg.* p. 27; Ralfs, *Ann. N. H.* 1843. xii. p. 346; Thwaites, *ibid.* 1848. i. p. 168; Smith, *Brit. Diat.* ii. 54; Rabenh. *Fl. Alg. Eur.* ii. p. 37; O'Meara, *Q. Mic. Jn.* ix. 150.

MEMBRANES, UNDULATING.—These are said to be simple membranous bands, one margin only of which is attached, the other being free and exhibiting an undulatory motion. They are allied to and answer the same purpose as cilia. They are described as occurring upon the spermatozoa of salamanders and tritons; as forming longitudinal processes in the water-vessels of some Annelida, as the Turbellaria; also as existing in some Infusoria, as *Trichodina*, and some Rotatoria. Some authors have regarded them as consisting of rows of cilia or a spiral fibre, and not membranes. They are most easily examined in the spermatozoa of the triton, in which we believe the appearance of an undulating membrane arises from the existence of a fibre coiled around the spermatozoa, and undulating throughout its length (Pl. 41. fig. 17). This opinion is based upon the circumstance that if the coiled fibre be detached from the proper filament of a spermatozoon or spermatozoid, no margins of the (lacerated) membrane can be detected other than that visible at first, and which really represents the coiled fibre. This, however, is an interesting subject for further investigation. Siebold, who has paid most attention to it, remarks that *Trypanosoma Grubii*, a supposed entozoon found in the blood of frogs and fishes, is not an independent animal, but simply an undulating membrane swimming freely.

Bibl. Siebold, *Sieb. und Kölliker's Zeitschr.* Bd. ii. p. 356, *and the Bibl. therein.*

See Mucous and Serous Membranes.

MEMBRANIP'ORA, Johnst.—A genus of marine Polyzoa, of the family Membraniporidæ.

Eight British species; usually found incrusting sea-weeds, more rarely shells and stones.

M. pilosa (Pl. 33. fig. 18). Orifices of the cells with one long hair, and several spinous teeth. Very common.

MEMBRANIPOR'IDÆ.—A family of Cheilostomatous Infundibulate Polyzoa.

Distinguished by the expanded, incrusting, stony polypidom, and the horizontal quincuncial cells. Genera:

1. *Membranipora.* Cells open in front, with raised margins.

2. *Lepralia.* Cells closed in front, polypidom spreading circularly.

Bibl. Johnston, *Brit. Zooph.*; Busk, *Cat. of Mar. Polyz.* (Brit. Mus.); Gosse, *Mar. Zool.* ii. 16.

MENI'PEA, Lamx.—A genus of Infundibulate Cheilostomatous Polyzoa, of the family Cellulariadæ.

Char. Cells oblong, tapering downwards, not perforate behind, with one or two sessile birds'-heads in front below the orifice. One British species:—

M. ternata (*Cellularia ternata*, Johnst.). Cells elongated, greatly tapering downwards, three in each internode, with a stalked operculum protecting the orifice; operculum expanded, entire, two spines on the upper margin; anterior birds'-head single.

Bibl. Johnston, *Brit. Zooph.* 335; Busk, *Cat. (Brit. Mus.)* 20.

MENIS'CIUM.—A genus of Grammitideæ (Polypodioid Ferns).

MENIS'PORA, Pers. — A genus of Mucedines (Hyphomycetous Fungi), one species of which, *M. lucida*, Corda, is recorded as British, growing on decayed wood.

Bibl. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. vii. p. 101; Corda, *Icones*, i. pl. 4. fig. 223.

MENOID'IUM, Perty.—A genus of Monadina.

Char. Body small, crescentic, thicker on the outer or convex margin, containing internally small molecules and vesicles; colourless, or occupied with a little chlorophyll.

M. pellucidum recalls by its figure a little *Closterium Lunula*, not rounded, but flattened like a sickle. Movement tolerably rapid, jerking and revolving, 1-670 to 1-430″.

Bibl. Pritchard, *Infusoria*, p. 502.

MEREN'CHYMA.—A name applied by some authors to the form of vegetable cellular tissue where the cells are of circular, ellipsoidal, or irregularly rounded outline; ordinarily known as "lax parenchyma."

MERID'ION, Leibl.—A genus of Diatomaceæ.

Char. Frustules (in front view) wedge-shaped, united laterally so as to form segments of circles or spiral bands. Aquatic.

Frustules in side view obovate, and furnished with coarse transverse striæ visible under ordinary illumination, which extend into the front view.

Kützing distinguishes *Meridion*, in which the frustules form a spiral (helical) band, from *Eumeridion*, in which they form a convolute band.

1. *Meridion circulare*, Ag. (Pl. 13. fig. 7: *a*, front view; *b*, side view). Frustules in side view simply obovate, forming a spiral (helical) band or filament; length of frustules 1-600 to 1-375″.

2. *Meridion constrictum*, Kg. (Pl. 12. fig. 28, filament flattened, and frustules (front view) separated by drying; *a*, convolute filament; *b*, side view). Frustules in side view constricted near the broad end, attenuate towards the narrow end, and attached to a hemispherical stipes or cushion.

Bibl. Kütz. *Bacill.* p. 41, and *Sp. Alg.* p. 10; Ralfs, *Ann. N. H.* 1843. xii. p. 457; Smith, *Brit. Diat.* ii. 5; Rabenht. *Fl. Eur. Alg.* i. 295.

MERISMOPÆ'DIA, Meyen. See Sarcina and Gonium.

MERIZOMY'RIA, Ktz.—A genus of Rivulariaceæ (Algæ).

Char. Filaments moniliform, upper cells subulate, and basal cells lasting, contained in a mucous matrix, and constituting an amorphous thallus. Continent of Europe.

Bibl. Rabenh. *Fl. Alg. Eur.* iii. p. 224.

MERMIS, Duj.—A genus of Entozoa.

M. nigrescens resembles *Gordius*, but differs from it principally in the vulva of the female being transverse and situated near the anterior end of the body, whilst in *Gordius* this is placed at the posterior end. Eggs black.

It is found in the newly dug-up damp earth of gardens, and in the intestines of insects.

Bibl. Duj. *Ann. d. Sc. Nat.* 2 sér. xviii.

p. 129, and *Hist. Nat. d. Helminthes*, p. 294; Siebold, *Entom. Zeit.* 1842. p. 146; Meissner, *Siebold and Kölliker's Zeitschrift, &c.* 1853.

MERU'LIUS, Hall. Dry-rot.—A genus of Agaricini (Hymenomycetous Fungi), distinguished by the veiny or sinuously plicate folds of the hymenium, these folds not being distinct from the flesh of the pileus, and forming angular or serrated pores. *M. lachrymans* is the dry-rot fungus. The mycelium is composed of filaments creeping in the substance of the infected wood, disorganizing and feeding on this as it decays. The fruit is at first white and cottony, forming an effused pileus from 1 to 8″ broad; subsequently ferruginous or deep orange. The irregular folds finally discharge a watery liquid, whence the name.

The most efficacious remedies against dry-rot are creasote and carbolic acid. Corrosive sublimate, though at first efficacious, seems to lose its virtue after a time.

Several species of the genus have been found in England in addition to *M. lachrymans*.

Bibl. Berk. *Brit. Flora*, ii. pt. 2, p. 129; Sowerby, *Fungi*, pl. 113.

MESOCAR'PUS, Hassall (*Sphærocarpus*, Kütz.).—A genus of Zygnemaceæ (Confervoid Algæ), with evenly distributed cell-contents, producing in conjugation a cross branch, in which is formed a round spore. It often happens that all the successive members of a long series of cells conjugate with another similar series, so as to produce a ladder-like body, the "rounds" of which are formed of the transverse processes (*trabeculæ*, Kütz.). The only kind of reproduction yet observed is that by the spores formed in the transverse branch from the conjoined contents of two cells; but it is possible that zoospores and encysted conditions of these occur, as in Spirogyra and Mougeotia. The stellate encysted bodies found in most of the allied plants have been seen in *M. scalaris* by Thwaites. Thwaites also observed a division of the contents of the spore into four parts, such as occurs in Œdogonieæ.

1. *M. scalaris*, Hass. (fig. 138, p. 196). Sterile filaments 1-1800 to 1-1440″ in diameter, 6 times as long; sporanges oval or round. Hass. pl. 42.

2. *M. depressus*, Hass. Sterile filaments 1-2880 to 1-2400″ in diam., 6 to 8 times as long; spores globose or elliptical. Hass. pl. 44. fig. 1.

M. intricatus, Hassall, is apparently the same as *M. scalaris*; all the other forms may be brought under *M. depressus*.

Bibl. Hassall, *Brit. Fr. Alg.* p. 166, pls. 41–45; Kützing, *Sp. Alg.* p. 435; *Tab. Phyc.* v. (*Sphærocarpus*), pls. 5–7; Thwaites, *Ann. Nat. Hist.* xvii. 262.

MESOCE'NA, Ehr.—A doubtful genus of Diatomaceæ, according to Ehrenberg and Kützing.

The bodies referred to this title consist of single siliceous rings, oval or angular frameworks, without a centre, and mostly with external and sometimes internal spines arising from them; and many are fossils.

Whether they are spicula of Echinodermata or not, remains to be decided. Diameter from 1-750 to 1-400″.

M. octogona, Ehr., Pl. 19. fig. 1.

Bibl. Ehrenberg, *Ber. d. Berl. Akad.* 1840; Kützing, *Bacill.* 139, and *Sp. Alg.* p. 142.

MESOGLO'IA, Ag.—A genus of Chordariaceæ (Fucoid Algæ), with filiform, much-branched fronds, of gelatinous character; the axis of the filaments composed of interlacing longitudinal cells, with gelatinous interposed matter; the periphery of radiating, dichotomous, coloured filaments. The fructification consists of unilocular and multilocular sporanges; the former are ovate sacs (fig. 458) occurring attached to

Fig. 458.

Mesogloia vermicularis.

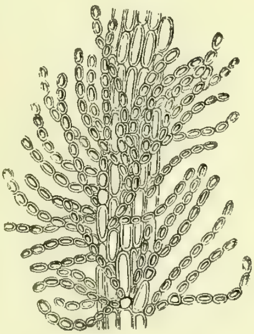
Peripheral ramuli, unilocular sporanges and the filaments upon which the jointed sporanges arise.

Magnified 50 diameters.

the ramuli of the periphery; the latter are produced by ramifications of other ramuli surrounding them (fig. 458). Both kinds produce ciliated zoospores, which germinate. *M. vermicularis* (figs. 458, 459), an

olive-green or yellowish frond, 6″ high, is common on rocks and stones between tide-marks. *M. virescens*, a smaller species, is not uncommon.

Fig. 459.



Mesogloia vermicularis.
Portion of a filament.
Magnified 10 diameters.

BIBL. Harvey, *Brit. Mar. Alg.* p. 47, pl. 10 B; *Phyc. Brit.* pls. 31 & 83; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 237, pl. 27.

MESOTÆ'RIUM, Näg.—A genus probably identical with Palmoglœa.

BIBL. Archer, *Qu. Mic. Jn.* iv. n. s. 109.

METACY'PRIS, B. & R.—One of the *Cytheridæ*: carapace tumid and cordate; upper antennæ long and setose. Lakes and rivers of England, Ireland, and Holland.

BIBL. Brady and Robertson, *Ann. N. H.* 4, vi. 19; ix. 51.

METAMORPHOSES, INSECT. — The structural changes which progress during metamorphosis afford abundant scope for microscopic research.

BIBL. Newport, *Art. Insect.* in Todd, *Cycl. Anat.*; Blanchard and Duncan, *Metam.*; Lubbock, *Nature Series.*

METAMORPHOSES OF TISSUES.—The degenerations of the tissues, characterized by an alteration in their quality and impairment of function. They are divided into metamorphoses and infiltrations. The metamorphoses are characterized by the direct change of the albuminoid constituents of a tissue into a new material, which is usually followed by the destruction of the histological elements, and the softening of the intercellular substance. They include fatty, mucoid, and colloid degeneration.

BIBL. Green, *Path. and Morb. Anat.*

METEORITES. — Transparent sections being made out of small fragments of meteorites, many mineral substances may be recognized to occur here and there; but the microscope and even polarized light fail to distinguish the kinds of the crystals. It is best to examine the bruised débris; and minute crystals may be sorted out, and removed for examination by means of the microscope.

BIBL. Maskelyne, *Proc. Roy. Soc.* 1870.

METOPIDIA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes two, red, frontal; foot forked; carapace depressed or prismatic; anterior and upper part of head naked or uncinate; no hood. =*Lepadella* with two frontal eyes. Lorica closed beneath.

M. triptera (Pl. 35. fig. 7). Carapace ovate, accurately trilateral, crested on the back. Aquatic; length 1-288 to 1-144″.

Two other species, E., to which Gosse adds two.

BIBL. Ehr. *Infus.* p. 477; Gosse, *Ann. N. H.* 1851. viii. p. 201.

METO'PUS, Clap. et Lach.—A genus of Bursarina (Infusoria ciliata).

Char. Buccal fossa oblique and elongate, dominated by a cupola-shaped prolongation of the anterior part of the body. Buccal cilia more vigorous than those of the rest of the surface.

BIBL. Claparède et Lach. *Etudes*, p. 254.

METZGE'RIA, Raddi.—A genus of Pelliеæ (Hepaticæ), comprehending *Jungermannia furcata*, L. and *J. pubescens*, Schrank, growing on trunks of trees, rocks, &c. in very moist places.

BIBL. Hook. *Brit. Flor.* ii. pt. 1. 131; *Brit. Jungermann.* pls. 55, 56 & 73; Endlicher, *Gen. Plant.* Supp. 1. p. 1338; Hofmeister, *Vergleich. Untersuch.* p. 10, pl. 4.

MICA.—This mineral substance, which is often erroneously called talc in the shops, was formerly used for covering mounted objects, but is now replaced by thin glass. It is, however, occasionally useful in applying a red heat to objects, as Diatomaceæ, &c., where it is required not to change the position of the object. It often contains crystalline and crystalloidal inorganic mineral substances, as metallic oxides, &c., of interesting appearance.

Thin plates of mica are used also in bringing out colours in objects with polarized light. See POLARIZATION.

MICRASTE'RIAS, Ag. —A genus of Desmidiaceæ (Confervoid Algæ).

Char. Cell single, lenticular, deeply di-

vided into two-lobed segments; lobes incisodentate (rarely only bidentate), and generally radiating.

Sporangia spherical, with stout spines (Pl. 10. fig. 12).

Numerous British species (Ralfs).

1. *M. denticulata* (Pl. 10. fig. 11, undergoing division; fig. 12, sporangium). Cell circular, surface smooth; segments five-lobed; lobes dichotomously divided, ultimate subdivisions truncato-emarginate, with rounded angles. Length 1-113″. Common.

2. *M. rotata* (Pl. 10. fig. 13). Cell circular, smooth; segments five-lobed; lobes dichotomously incised, ultimate subdivisions bidentate. Length 1-91″. Common.

Bibl. Ralfs, *Brit. Desmid.* p. 68; Lobb, *Trans. Mic. Soc.* 1861; Dixon, *Mic. Jour.* 1859; Archer, *in Pritchard, Infus.*; Bailey, *Smithson Contr.*; Archer, *Mic. Jour.* 1862; Rabenh. *Fl. Alg. Eur.* iii. p. 187.

MICROCLA'DIA, Grev.— A genus of Ceramiaceæ (Florideous Algæ), containing one rare British species, *M. glandulosa*, with a dichotomously branched, filiform, compressed frond 1 to 2″ high, of a bright rose colour. Its fructification consists of (1) roundish, sessile involucrated favellæ with *spores*, and (2) *tetraspores* (tetrahedrally arranged) imbedded in the ramules.

Bibl. Harvey, *Brit. Mar. Alg.* p. 160; pl. 22 B; *Phyc. Brit.* pl. 29; Grev. *Alg. Brit.* t. xix.

MICROCO'DON, Ehr.—A genus of Rotatoria, belonging to the family Megalotrochæa.

Char. Eye single; no carapace; foot styliform. Jaws two, each with a single tooth.

M. clavus (Pl. 35. fig. 8). Body campanulate, foot equalling or exceeding the body in length. Aquatic. Length 1-288 to 1-216 .

Bibl. Ehr. *Infus.* p. 395.

MICROCO'LEUS, Desmaz. (*Chthonoblastus*, Kütz.).—A genus of Oscillatoriaceæ (Confervoid Algæ), with fronds forming strata on moist ground, paths, mud, &c. These plants may be described as bundles of *Oscillatoria*-filaments enclosed in a common gelatinous sheath, which is simple or irregularly dichotomously branched, and forms twisted interwoven masses. The structure of the filaments appears to be identical with that occurring in Oscillatoria, described under that head; the filaments oscillate: the mode of origin of the enclosing sheath is obscure; but it would appear to be formed of the gelatinous half-dissolved outer membranes of the enclosed filaments. No formation of spores or gonidia has been described. *M. repens*, Harv. (Pl. 4. fig. 9 *a*, the open end of a sheath), is very common on damp paths, &c., its sheaths are branched; *M. anguiformis*, Harv., occurs on the mud of brackish pools; its sheaths are said to be simple. *M. gracilis*, Hassall, said to be found in similar situations, has no character attached to it.

Bibl. Harvey, *Brit. Mar. Alg.* p. 227, pl. 26 D; *Phyc. Brit.* pl. 249; Hassall, *Br. Freshw. Alg.* p. 260, pl. 70; Kütz. *Tab. Phyc.* i. pls. 54–58.

MICROCYS'TIS, Kütz.— A genus of Palmellaceæ (Confervoid Algæ), of which we are unable to identify any British species except *M. æruginosa*, for which see Clathrocystis, and with some probability the plant described by Mr. Currey under the name of *Monostroma roseum*.

Bibl. Kütz. *Linnæa*, viii. p. 342; *Sp. Alg.* p. 208; *Tab. Phyc.* pls. 8, 9; Currey, *Qu. Mic. Jn.* vi. p. 214; Rabenh. *Fl. Eur. Alg.* ii. 51.

MICROGLE'NA, Ehr.—A genus of Infusoria, of the family Monadina, E.

Char. Tail absent; body truncated in front, with a single flagelliform filament; a red eye-spot present.

Probably the spores of Algæ.

1. *M. punctifera* (Pl. 24. fig. 43 *a*). Body yellow, ovate, subconical, attenuate posteriorly, red eye-spot accompanied by a blackish frontal spot (in Ehrenberg's figures, some have one, some two red eye-spots). Aquatic; length 1-620″.

2. *M. monadina* (Pl. 24. fig. 43 *b*). Body ovate, equally rounded at both ends, bright green; eye-spot red and single. Aquatc; length 1-1150 to 1-620″.

Bibl. Ehr. *Infus.* p. 25.

MICROGONID'IA. Special reproductive cells or *androspores*, which ultimately produce antheridia, in which spermatozoids are formed. They may be studied in *Protococcus*, *Docidium*, *Pediastrum*, *Hydrodictyon*, *Œdogonium*, &c.

MICROHALO'A, Kütz.—A genus of Palmellaceæ (Confervoid Algæ), consisting of microscopic gelatinous patches, floating in water, crowded with minute green gonidia. *M. Icthyoblabe* (quite distinct from Clathrocystis) occurs in Britain; and Hassall's *Sorospora virescens* belongs here. Probably a *Chlorococcus*.

Bibl. Kütz. *Sp. Alg.* p. 207; *Tab. Phyc.* pls. 6, 7; Hassall, *Brit. Fr. Alg.* p. 326; Rabenh. *Fl. Eur. Alg.* iii. 60.

MICRO'MEGA, Ag.—A genus of Diatomaceæ, which is merged into *Schizonemus.*

Char. Frustules arranged in longitudinal rows within gelatinous tubes or surrounded by slender curved or crisped fibres—these being enclosed in other gelatinous tubes, forming filiform branched fronds; valves resembling those of *Navicula.* Marine.

Kützing notices the occurrence of sporangia or sporange-like bodies (spermatia) filled with the frustules, within the substance of the sheaths, and formed "from the dilatation of the naviculæ" (frustules); but the exact nature of the process is not described nor understood. This formation of brood-sporangia, as they might be called, would appear to resemble that occurring in the Desmidiaceæ (Pl. 6. fig. 3 A *d*).

Kützing describes twenty-eight species, and divides them into two sections—in one the filaments being slender and capillary, in the other rigid, cartilaginous, and thicker.

M. parasiticum (Pl. 13. fig. 8: *b*, portion of a filament magnified; *c*, side view; *d*, front view of frustule). Filaments slender, wavy, tufted, cartilagino-gelatinous, yellowish (sometimes brown), much branched, capillary; frustules crowded; length of frustules 1-1380″.

Parasitic upon larger marine algæ.

Bibl. Kütz. *Bacill.* p. 116; *Sp. Alg.* p. 105; Rabenh. *Fl. Eur. Alg.* i. 265.

MICROM'ETER. See Introduction, p. xxv, and Measurement.

MICROPE'RA, Lév.—A genus of Sphæronemei (Coniomycetous Fungi), of which one species is described as British, *M. drupacearum* (*Cenangium Cerasi junior,* Fr., *Sphæria dubia,* Pers.), growing on dead branches of the cherry-tree. It forms whitish tubercles which split the bark transversely, composed of somewhat cylindrical conceptacles, conjoined at the base, the white mealy ostiole projecting; the linear spores are yellowish and curved at the apex.

Bibl. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. v. 380; Léveillé, *Ann. des Sc. Nat.* 3 sér. v. p. 283; *British Flora,* ii. pt. p. 2. 211.

MICROPYLE (of Animals). See Ovum.

MICROSCOPE.—The first Section of the Introduction consists of remarks upon the microscope and microscopic apparatus.

MICRO-SPECTROSCOPE.—The spectrum-analysis of coloured microscopic objects may be attempted by means of one or more prisms in connexion with the simple or compound microscope. The prism, or combination of prisms, may be placed beneath the achromatic condenser in the body of the microscope and in relation with the eyepiece; and this last arrangement is the most convenient. Sorby and Browning have elaborated the spectroscopic eyepiece. Above the eye-glass of an eyepiece (which is chromatic and capable of focal adjustment for rays of different refrangibilities) there is placed a tube containing a series of five prisms, two of flint glass interposed between three of crown glass in such a manner that the emergent rays which have been separated by the dispersive action of the flint-glass prisms are parallel to the rays which enter the combination. Below the eye-glass, in the place of the ordinary stop is a diaphragm with a narrow slit, which limits the admission of light. Objects placed on the stage of the microscope, provided they transmit a sufficient quantity of light, may then be examined, and their spectra noted. If it is desired to compare their spectra with others, provision is made for the formation of a second spectrum, by the insertion of a right-angled prism that covers one half of the above-mentioned slit and reflects upwards the light transmitted through an aperture on the side of the eyepiece. For the production of the ordinary spectrum, it is only requisite to reflect light into this aperture from a small mirror carried at the side; whilst for the production of the spectrum of any substance through which the light reflected from the mirror can be transmitted, it is only necessary to place the slide carrying the section or crystalline film on the tube containing the solution in the frame adapted to receive it. In either case this second spectrum is seen by the eye of the observer alongside of that produced by the object viewed through the body of the microscope, so that the two can be exactly compared. Some care is requisite in managing the arrangement and number of the prisms according to the amount of dispersive power required; and Sorby recommends, for instance, in the examination of the blood, two rectangular prisms.

Bibl. Sorby, *Quart. Jn. Sci.* 1865, *Pop. Sci. Review,* 1866, *Qu. Mic. Jn.* 1871, *M. Mic. Jn.* 1872, 1873, *Proc. Roy. Soc.* 1873; Stokes, *Jn. Chem. Soc.* 1864; Huggins, *Trans. Mic. Soc.* 1865; Browning, *Trans. Mic. Soc.* 1865, *Qu. Mic. Jn.* v., ix., *M. Mic. Jn.* 1873, 66; Valentin, *Schultze's Arch.* 7. B. 3. H.; R. Lankester, *Qu. Mic. Jn.* ix.; J. Hogg, *M. Mic. Jn.* 1869, 121; Crookes's

Binocular, &c., M. Mic. Jn. 1869, 371; Carpenter, *The Micros.*; Suffolk, *Spec. Anal.*

MICROS'PORA, Thuret.—A genus of Confervaceæ.

Char. Filaments simple and articulate. Joints all fructiferous, propagation by zoogonidia, which have two cilia. Many so-called Confervæ are associated with this genus.

Bibl. Thuret, *Rech. sur les Zoos.*; Rabenht. *Krypt. Flor.*; *Fl. Alg. Eur.* iii. p. 321.

MICROSPORES.—The small kind of spores produced by Lycopodiaceæ and Marsileaceæ in contradistinction to megaspores or macrospores. When sown, they produce sperm-cells and spermatozoids.

MICROTHAM'NION, Naeg.—A genus of Chætophoraceæ (Algæ).

Char. Filaments much branched, rigid, articulate, narrow. Joints longer than broad and slightly tumid. Propagation by zoogonidia.

Bibl. Rabenht. *Fl. Alg. Eur.* iii. p. 375.

MICROTHE'CA, Ehr.—A marine organism of doubtful nature.

It consists of yellow, flattened, rectangular (side view) bodies, with four equidistant spines projecting from each end; the colour arises from the contents; no transverse line of division; entire length 1-216″.

Bibl. Ehr. *Infus.* p. 164.

MICROZY'MATA.—Molecular granules normally in the cells of animals; they can group themselves, elongate slowly, and then resemble *Bacteria*. Syn. for *Bacteria*.

Bibl. Béchamp, *Compt. Rend.* May 1868; Estor, *Compt. Rend.* August 1868; *Q. Micr. Jn.* 1868, p. 274.

MIELICHHOFE'RIA, Hornsch.—A genus of Bryaceous Mosses, containing one British species, *M. nitida*, sometimes referred to *Weissia* (fig. 81, p. 115).

MIGRATION OF CELLS.—For migration of blood-cells, white corpuscles, and corneal cells, see Inflammation and Blood. The migration of pus-corpuscles has been demonstrated, and their amœboid movements, and also those of the cells which are developed out of connective tissue during the inflammatory process. Amœboid cells exist normally in connective tissue: some, which are finely granular, give off a variable number of processes, which join with those of others, and there is little movement besides this; others, which are smaller, migrate; and their several small ground-nuclei may be shown by the action of acetic acid.

Saviotti has observed the pigment cells of the foot-web of the frog to pass into the capillaries and become carried along by the blood. The large cells of the frog's ovum are said to move from the floor of the cleavage-cavity, and pass to the roof to form a new layer of blastoderm. Ray Lankester has noticed migrating cells in *Lumbriculus* and in *Tubifex*. Migrating cells also occur in the anterior epithelium of the cornea and beneath it.

Bibl. See *Blood and Inflammation*; Stricker, *Hum. & Comp. Hist.*; Rindfleisch, *Path. Hist.*; Ray Lankester, *Qu. Micr. Jn.* x. p. 265.

MILI'OLA, Lamarck.—An extensive genus of Imperforate (Porcellaneous) Foraminifera, in which the chambers grow alternately on two or more sides of the long axis of the suboval shell: if on two sides they form *Biloculina* (*B. ringens*, Pl. 18. fig. 3) and *Spiroloculina* (*Sp. planulata*, Pl. 18. f. 7), many and thin in the latter, few and thick in the former; if on three sides, they form *Triloculina* (*Tr. trigonula*, Pl. 18. fig. 4). Irregular development of the edges of the chambers gives rise to the many Quinqueloculine varieties (*Quinqueloculina seminulum*, Pl. 18. fig. 5; *Q. Brongniartii*, fig. 6)—from three to eight chambers being visible on one side, and from two to six on the other. *Uniloculina* (*U. indica*, Pl. 18. fig. 2) is possibly a young or arrested *Miliola*. *Cruciloculina* has a cross-slit opening, whilst the others have usually a crescentic aperture, owing to the presence of a tongue (homologue of the septum); but it may be round and produced.

In its young or Adelosine stage, *Miliola* differs from *Cornuspira* by its segmental stricture. See *M. obesa* junior, Schultze, Pl. 18. fig. 1. Hauerina and Fabularia are closely allied genera.

Fossil in all formations from the Trias upwards; and common in existing seas, chiefly in shallow water (*M. seminulum*, Pl. 18. fig. 5).

Bibl. Williamson, *Rec. For.* 78; Schultze, *Org. Polyth.* 57; Parker, *Tr. Micr. Soc.* n. s. vi. 53; Parker & Jones, *Ann. N. H.* 2, xix. 299; Carpenter, *Introd. For.* 74.

MILK.—This liquid consists of a solution of caseine and certain salts, holding in suspension minute globules of fatty matter (butter).

The fluid portion possesses no microscopic

peculiarities. The globules are very numerous, round, and vary in size from mere molecules to 1-3000 or 1-2000″ in diameter. Each is surrounded by a pellicle or coat of caseine, which prevents the globules from fusing into each other. If a portion of a drop of milk be placed upon a slide, and the thin glass cover be moved to and fro, the coat of caseine will be ruptured, the globules of oil will become confluent, and shreds of the coats will be visible. If acetic acid be added, the coats will be acted upon, and the confluence also produced. The same effect occurs naturally in sour milk; hence in this the globules are often much larger than the above dimensions, and irregular in form, frequently becoming elongated and united in twos, so as to bear some resemblance to the young state of a fungus.

The milk first secreted after parturition, called the colostrum, differs considerably from the normal liquid. The fatty globules contained in it vary greatly in size, often being very large, and existing within isolated or aggregated epithelial cells, some of them resembling exudation-corpuscles.

Dr. Peddie's paper on the human milk in relation to medical practice, is well worthy of perusal.

Bibl. Kölliker, *Mikrosk. Anat.* ii.; Donné, *Cours. de Micros.*; Wagner, *Hand. d. Physiol.* art. *Milch*; Peddie, *Ed. Monthly Journ.* 1840, and the *Bibl.* of Chemistry, Animal.

MILK-VESSELS. See Laticiferous tissue.

MILLON'S TEST, or Test-liquid.—This is a strongly acid (nitric and nitrous) solution of proto- and pernitrate of mercury.

The following substances and tissues are coloured red by the test: albumen, caseine, chondrine, crystalline, epidermis, feathers, fibrine, gelatine, gluten, horn, legumine, proteine, silk, wool.

The following, when pure, are not coloured: cellulose, chitine, cotton, gum (arabic), linen and starch.

Bibl. Millon, *Comptes Rendus,* 1849, or *Chem. Gaz.* 1849, vii. p. 87.

MILNE'SIUM, Doyère. — A genus of Arachnida, of the order Tardigrada (Colopoda).

Char. Head with two very short palpiform appendages at its anterior and lateral parts; mouth terminated by a sucker surrounded by palps; skin soft, transversely furrowed; legs four pairs; rings of the body divided into two segments.

M. tardigradum (Pl. 41. fig. 9). Mouth surrounded by six minute unequal palps, symmetrically arranged, diminishing in size from the upper to the lower part; head rounded in front when the mouth is retracted; eye-spots tolerably large and granular; pharyngeal tube much dilated, styles very small, bulb elongated and pyriform, without an internal framework; body transparent, attenuated at both ends, especially the posterior; skin pale brownish yellow; three anterior pairs of legs nearly equal, the fourth very short, resembling two tubercles, with scarcely a trace of annuliform division; claws four, two terminal, and in the form of elongated filaments hooked at the end, and each supported on a distinct tubercle; two inferior and internal, the anterior divided into three strongly curved hooks, the posterior into two; hooks or terminal filaments of the fourth pair longer than those of the first three. Movement active. Length 1-50 to 1-40″.

Bibl. Doyère, *Ann. des Sc. Nat.*

MIMOSEL'LA, Hincks.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Vesiculariadæ.

Char. Polypidom confervoid, jointed, and branched; cells ovate, opposite, with a basal joint; animals with eight tentacles and a gizzard.

M. gracilis. Branches erect, arising from a creeping fibre. On sea-weeds.

Bibl. Hincks. *Ann. Nat. Hist.* viii. 359.

MINERALOGY, application of the microscope to.—The following substances may be recognized in transparent minerals or blowpipe beads, by means of the characteristic absorption-bands seen in the spectrum, even when they are much coloured by the oxides of iron, manganese, or nickel, viz. didymium, erbium, uranium, cobalt, chromium, copper, manganese, and jargonia. In one method the substance is fused with borax or microcosmic salt, so as to give a clear bead, and the spectrum is examined by means of the spectrum eyepiece. In the other method, the saturated borax bead is kept hot over the lamp, so that crystals may be deposited in it. Many kinds of crystals may be thus distinguished. See Micro-spectroscope and Rocks.

Bibl. Sorby, *Qu. Mic. Jn.* 1869, p. 182.

MIRROR OF SŒMMERING. See Introduction, p. xx.

MISCHOCOC'CUS, Naeg. A genus of Palmellaceæ (Algæ).

Char. Thallus gelatinous, branched; the terminal cells of the branchlets in pairs or

fours. Hab. Switzerland, Germany, stagnant pools.

BIBL. Rabenht. *Fl. Alg. Eur.* iii. p. 54.

MISLETOE. See VISCUM.

MITES.—The animals usually included under this indefinite term are species of genera belonging to the order Acarina among the Arachnida.

MNIA'CEÆ. — A tribe of Mnioideæ (Mosses), of Bryoid habit, but with firm, rigid, and usually undulated leaves, mostly increasing in size toward the summit of the stem. The British genera are :—*Cinclidium, Mnium, Georgia*, and *Timmia*. See genera.

MNIADELPHA'CEÆ. — A family of Pleurocarpous Mosses, with the leaves arranged in four or more series, and composed of parenchymatous cells, mostly equally hexagonal and Mnioid, very smooth, pellucid, destitute of a distinct primordial utricle, the lowest decurrent on the stem at the base, larger, spongy, lax, mostly beautifully dark-tinged, never single, slender.

British Genus.

Daltonia. Calyptra mitre-shaped, bell-shaped, elegantly fringed at the base. Peristome double (*Neckeroid*). External: sixteen narrow, subulate, trabeculate teeth, reflexed when moistened; internal: an equal number of similar cilia, alternating with the teeth, devoid of a basilar membrane.

MNIOI'DEÆ.—A family of operculate Mosses, ordinarily of acrocarpous habit, but sometimes pleurocarpous, with broadly oval, spathulate, oval or lanceolate, flattish leaves, having a very prominent, thick dorsal nerve. The base of the leaves composed of somewhat parallelogrammic cells, rounded-hexagonal or with equal walls towards the apex, very full of chlorophyll, or with the primordial utricle mostly very conspicuous, or much thickened, firm, rarely papillose. This family is divided into two tribes: MNIACEÆ and POLYTRICHACEÆ.

MNI'UM, Dill.—A genus of Mniaceous Mosses, of acrocarpous and pleurocarpous habit, including many *Brya* of the British Flora. Among the commonest is *M. hornum*=*Bryum hornum*, L.

MOCHA STONES.—The varieties of chalcedony known under this name contain a number of bodies (mineral dendrites) which have been mistaken for plants.

Compare AGATE, SILICA, and FLINT.

BIBL. K. Müller, *Ann. Nat. Hist.* 1843, xi. p. 415.

MOH'RIA, Swartz.—A genus of Schizæous Ferns. Exotic (fig. 460).

Fig. 460.

Mohria thurifraga.
A pinnule with sporanges.
Magnified 25 diameters.

MOI'NA, Baird.—A genus of Entomostraca, of the order Cladocera, and family Daphniadæ.

Char. Head rounded and obtuse; superior antennæ of considerable length, of one piece, and arising from the front of the head near the middle; inferior antennæ large, fleshy at the base, and two-branched, one branch three-jointed, the other four-jointed; legs five pairs.

1. *M. rectirostris* (Pl. 14. fig. 26). Carapace almost straight or but slightly rounded behind. Aquatic.

2. *M. brachiata* or *branchiata.* Carapace greatly rounded behind. Aquatic.

BIBL. Baird, *Brit. Entomos.* p. 100.

MOIST CHAMBER.—First introduced by Recklinghausen; it enables the object under microscopic examination to be placed in a space saturated with moisture, and to be examined without or with the intervention of thin glass. Also it enables an immersion-lens to remain with its water in contact with thin glass over an object in any liquid for a considerable time. The simplest form is that of a large glass ring cemented to a broad glass plate; a thin and flexible caoutchouc membrane is fixed to the ring and to the object-glass by india-rubber rings. See Frey, *Das Mik.* p. 63.

MOLECULAR COALESCENCE. See LIME.

MOLECULAR MOTION.—When extremely minute particles of any substance immersed in water or other liquid are examined under the microscope, they are seen to be in a state of vivid motion. A little gamboge or Indian-ink mixed with water will exhibit the phenomenon distinctly

enough. The minute particles or molecules are seen to move irregularly, to the right and left, backwards and forwards, as if repelled by each other, until the attraction of gravitation ultimately overcomes the force upon which their motion depends, when they sink to the surface of the slide. This applies to the molecules of those substances which are heavier than water. In the case of those which are lighter than water, or the liquid in which they are immersed, the molecules ultimately become adherent to the thin glass covering the slide.

This motion is in no way connected with evaporation, for it takes place equally when this is completely prevented, just as when it is not. Neither light, electricity, magnetism nor chemical reagents exert any effect upon it. Heat is the only agent which affects it; this causes the motion to become more rapid. Hence it might be attributed to the various impulses which each particle receives from the radiant heat emitted by those adjacent. Or, as it takes place when the temperature is uniform, may it not arise from the physical repulsion of the molecules, uninterfered with by gravitation, hence free to move? The effect of heat would then be explicable, because this increases the natural repulsion of the particles of matter, as in the conversion of water into vapour.

Molecular motion plays a part in some common phenomena. Thus, it prevents turbid water from becoming rapidly clear by repose; by its agency also the disaggregated particles of animal or vegetable matter are diffused throughout the mass of the liquid.

The microscopist should become acquainted with the appearance of particles in molecular motion, as it might give rise to error. Thus particles under its influence might be mistaken for monads; or particles moved by cilia might be regarded as merely exhibiting this molecular motion.

Two circumstances appear most favourable for its production and continuance, in addition to the augmentation of temperature, viz. a very finely divided state of the matter, and the specific gravity of the matter and the liquid in which it is suspended being as nearly as possible coincident.

BIBL. R. Brown, *On Active Molecules, &c.*, *Add. Observ. on the same*, 8vo (*privately printed*); Duj. *Observ. au Mic.*; Griffith, *Med. Gaz.* 1843.

MOLES.—A pigmented state of the cutis (see SKIN), without marked changes in the *rete Malpighii* and the epidermis. Or the *rete* may be coloured, but not the overgrowth of the underlying papillary body. The pigment is deposited in the form of yellow, brown, or black granules, partly in the cells of the *rete* and connective tissue, partly outside them and in the papillary body. Sometimes it masks by its abundance all other peculiarities of structure.

BIBL. Rindfleisch, *Path. Hist.* i. 369 (Baxter tr.).

MOL'GULA, Forbes.—A genus of Tunicate Mollusca, of the family ASCIDIADÆ.

Two British species: *M. oculata*, adherent, bluish or purple, mottled with orange; $2\frac{1}{2}''$ in diameter: and *M. tubulosa*, free, in sand.

BIBL. That of the family.

MOLLUSCA.—A subkingdom of the Animal Kingdom, containing, according to some classifications, seven classes, viz. Brachiopoda, Ascidioida, Lamellibranchiata, Branchiogasteropoda, Pulmogasteropoda, Pteropoda, and Cephalopoda. The four classes last mentioned have some structures and peculiarities in common which separate them from the others. Their shell is either single or multivalve, but it is never bivalve as in the Lamellibranchiata and Brachiopoda; and they possess a TONGUE or ODONTOPHORE in the cavity of the mouth. A distinct head also exists in three of the classes, but not in Pteropoda. The Lamellibranchiata have bivalve shells and a mantle; and these correspond to the right and left sides of the body. Within the mantle are the branchial organs covered with cilia. They do not possess the odontophore. The Brachiopoda have also bivalve shells, which are either horny or calcareous, and which are articulated together by teeth and sockets. The mantle lines the interior of the valves of the shell, which correspond to the front and back of the body. There is no distinct head; and on each side of the mouth is a longer or shorter prolongation of the body provided with ciliated tentacula; these "arms" are often supported by a peculiar loop of shelly matter; and their presence gives the name to the class. The Ascidioida do not possess a calcareous shell, but a case or "test," which may vary in consistence from jelly to hard leather or horn. Their intestine is primarily bent towards the heart side of the body, and the nervous centre is not placed within its curve; and there is an atrial or water system. The subkingdom

contains classes, some of which are separated from others by great structural and physiological differences. Hence it is best to group the classes with an odontophore together, and ally them with the Lamellibranchiata as Mollusca, and to separate from them the Brachiopoda and Ascidioida, which with the Polyzoa, not placed by Cuvier amongst the Mollusca (see POLYZOA), should form a group or subkingdom, the Molluscoida. The Cephalopoda are represented by the nautilus and cuttlefish, the Pteropoda by the little Clio, the Pulmogasteropoda by the garden-snail, the Branchiogasteropoda by the whelk, the Lamellibranchiata by the oyster, the Ascidioida by the ascidia, and the Brachiopoda or lamp shells by *Terebratula* or *Lingula*.

Every portion of the structures of the Mollusca offers objects of interest to the microscopist. The motion of the cilia, the structure of the lining membrane of the viscera, the spermatozoa, the ovular growth and the nature of the sensory organs can be easily investigated. Remarks upon certain interesting structures occurring in the Mollusca will be found under TONGUE, SHELL, SNAILS (WATER-), MUSSEL, OYSTER, and OVUM. The calcareous concretions, crystals, and spicula met with in the integument or mantle of some mollusca are curious.

BIBL. Siebold, *Vergleich. Anat.* and the copious BIBL.; Vogt, *Zoologische Briefe*; Adams, *Genera of Recent Mollusca*; Forbes and Hanley, *Brit. Mollusca*; Woodward *on Shells*; R. Jones, *Animal Kingdom*, and *the articles in the Cycl. of Anat. and Phys.*; Huxley, *Elem. Comp. Anat.*; Deshayes, *Hist. Nat. des Moll.*; Turton, *Brit. Shells, by Gray*; Hogg, *Mic. Trans.* 1868.

MONACTI'NUS, Bail.—A genus of Desmidiaceæ = MONACTINIUM, Braun.

Distinguished from *Pediastrum* by the marginal cells having one horn only. Species:

1. *M. octonarius.* Marginal cells eight, central none.

2. *M. duodenarius* (Pl. 44. fig. 22). Marginal cells twelve, central three.

BIBL. Bailey, *Smith. Contribut.* 1853, p. 14; Rabenh. *Fl. Eur. Alg.* iii. 71.

MONADI'NA.—A family of Infusoria, according to Ehrenberg's system, but consisting of a heterogeneous group of imperfectly examined bodies.

Char. Carapace absent; no expansions; locomotive organs consisting of one or more flagelliform filaments or cilia at the anterior part of the body.

Ehrenberg distinguishes nine genera:

A. Tail none.
  a. No lips.
    a. Swimming.
      α. No eye-spot.
        1. Single .... 1. *Monas.*
        2. Grouped .... 2. *Uvella.*
      β. Eye-spot present.
        1. Single.
          * Flagelliform filaments, one or two .... 3. *Microglena.*
          ** Flagelliform filaments, four or five .... 4. *Chloraster.*
          *** Flagelliform filaments, numerous............... 5. *Phacelomonas.*
        2. Grouped .... 6. *Glenomorum.*
    b. Rolling .... 7. *Doxococcus.*
  b. Lips present........................ 8. *Chilomonas.*
B. Tail present .... 9. *Bodo.*

Dujardin's characters are (see p. 409):—animalcules without an integument, consisting of a glutinous, apparently homogeneous substance, susceptible of becoming agglutinated to other bodies and so drawn out and altered in form, with one or more flagelliform filaments as locomotive organs, and sometimes lateral or tail-like appendages.

Dujardin divides them thus:

MONADINA.

Isolated.	A single flagelliform filament	arising from the anterior extremity of the body	moving throughout its whole length	1. *Monas.*
			thicker and rigid at the base, movable at the end	2. *Cyclidium.*
		arising obliquely from behind an anterior prolongation		3. *Chilomonas.*
	A second filament,	lateral		4. *Amphimonas.*
		posterior		5. *Cercomonas.*
	Two equal filaments terminating the curved angles of the anterior end			6. *Trepomonas.*
	Four equal filaments in front, and two thicker ones behind			7. *Hexamita.*
	A second filament arising from the same spot as the flagelliform filament, but thicker, trailing and retracting			8. *Heteromita.*
	A filament and vibratile cilia			9. *Trichomonas.*
Aggregate.	Groups always free, revolving			10. *Uvella.*
	Groups originally fixed at the end of a branched polypidom or stalk			11. *Anthophysa.*

BIBL. Ehr. *Infus.* p. 1; Duj. *Infus.* p. 270.

MONADS are species of *Monas*, or of other genera of the family Monadina (Infusoria).

MONAS, Mull.—A genus of Infusoria, of the family Monadina.

Char. See MONADINA.

Ehrenberg describes many species, consisting mostly of the zoospores or lower forms of Algæ, and the young or swarm-germs of Infusoria.

1. *M. vinosa*, E. Ovate, uniformly rounded at each end, of a red-wine colour, motion slow and tremulous. Length 1-12,000 to 1-6000''.

Found upon the sides of glass vessels in which decaying vegetable matter has been kept, on the side next the light.

The characters of the genus given by Dujardin are:

No integument; form rounded or oblong, variable; no expansions; flagelliform filament single; motion slightly vacillating.

Dujardin describes ten species, which cannot be identified with those of Ehrenberg.

2. *M. lens*, D. (Pl. 24. fig. 44 *a*). Body rounded or discoidal and tubercular. Breadth 1-5200 to 1-1800''.

One of the most common organisms in animal and vegetable infusions. We have found one common in animal infusions (Pl. 24. fig. 44 *b*), perhaps the same as the above; but it possesses usually two filaments: on the left side is one without filaments, but with the body drawn out from adhesion to the slide.

3. *M. attenuata*, D. (Pl. 24. fig. 44 *c*). Body ovoid, narrowed at the ends, nodular, unequal; filament arising from the anterior narrowed portion. Length 1-1600''. Very abundant in stinking films floating on water containing decaying freshwater Algæ.

BIBL. Ehr. *Infus.* p. 3; Duj. *Infus.* p. 279.

MONE'RA, Haeckel.—A group of the kingdom Protista. In the Monera, which are the very lowest of all organisms, the protoplasm or sarcode (simply and solely by itself, without combining with other bodies) forms the whole structureless body of the fully developed animal. Nuclei and cell-membranes are never developed. The Monera are subdivided into Gymnomonera and Lepomonera. The Gymnomonera do not pass into a quiescent or resting condition, and do not surround themselves with a covering, and they propagate by fissiparous division. The Lepomonera pass into a resting stage, and surround themselves with a covering for the purposes of reproduction; they break up into spore-like bodies, which, on escaping, resemble the parent form. The genera of the first subdivision are *Protogenes*, *Protamœba*, and *Myxodictyum*; and those of the second, *Protomonas*, *Protomyxa*, *Vampyrella*, and *Myxastrum*. See PROTISTA.

BIBL. Cienkowski, *Schultz. Arch.* 1865, i. p. 203; Haeckel, *Zeit. f. wiss. Zool.* 1865, xv. p. 360; *Gener. Morphol. Jenai. Zeit.* 1868, iv.; P. Wright, transl. *Qu. Mic. Jn.* 1869.

MONILIFORM VESSELS.—When the constituent cells of spiral, annular, or scalariform vessels are short, they are usually more or less moniliform.

MONOCER'CA, Bory, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye red, single, cervical; foot-like tail simply styliform.

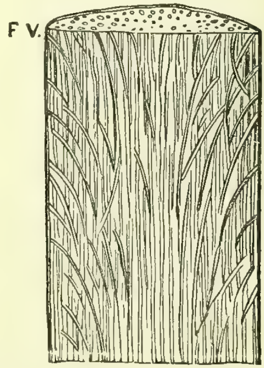
Gosse mentions a second eye situated in the breast of one (new) species. Ehrenberg describes three species, to which Gosse adds two.

M. rattus, E. (Pl. 35. fig. 9). Body ovate-oblong; forehead truncate, unarmed; foot styliform, as long as the body. Aquatic. Length 1-120''.

BIBL. Ehr. *Infus.* p. 422; Gosse, *Ann. Nat. Hist.* 1851, 199.

MONOCOTYLE'DONS. — One of the classes of Angiospermous Flowering Plants,

Fig. 461.



Reduced view of a stem of a Palm, showing the perpendicular and horizontal section, in which the fibro-vascular bundles F. V are seen isolated in the medullary parenchyma.

so called from the structure of the embryo contained in the seed, which in a large number of cases is of microscopic dimensions, and always requires the use of the simple microscope for its dissection. Some of the families placed under this head have usually an acotyledonous embryo, as Orchidaceæ; but these possess the character of the class

in all other respects. Among the most important of their other characters is the isolated condition of the fibro-vascular bundles forming the woody structures (see TISSUES, VEGETABLE). This character, mostly very evident both in perpendicular and horizontal sections of the stems, is illustrated by figs. 456 & 461.

MONOL'ABIS, Ehr.—A genus of Rotatoria, of the family Philodinæa.

Char. Eyes two, frontal; tail-like foot with two toes; horns absent.

Two species.

M. gracilis (Pl. 35. fig. 10). Body slender, no cervical process nor respiratory tube; teeth two in each jaw. Aquatic. Length 1-240 to 1-144''.

BIBL. Ehr. *Infus.* p. 497.

MONOR'MIA, Berkeley.—A genus of Nostochaceæ (Confervoid Algæ), distinguished by its definite, linear, convoluted frond, enclosing a single moniliform filament. It might readily be mistaken for a *Nostoc* if superficially observed; but its convoluted frond is devoid of the common membranous pellicle. The only known British species is *Monormia intricata*, Berk. The genus is identical with *Anabæna*, Bory.

This plant occurs in gelatinous masses, each about as large as a walnut and of a reddish-brown colour, floating in slightly brackish ditches. When the spermatic cells are quite mature, the definite outline of the linear frond is almost lost, and there is little to distinguish the plant from *Trichormus*, except the peculiar convolutions of the moniliform filament; the frond then also assumes a greenish tint.

BIBL. Berk. (*Glean. of Brit. Algæ*, t. 18); Ralfs, *Ann. Nat. Hist.* ser. 2. vol. v. pl. 8. fig. 1; Harvey, *Phyc. Britann.* t. 256; Hassall, *Brit. Fr. Algæ*, t. 75. fig. 11. *Nostoc intricatum*, Meneghini, *Anabæna intricata*, Kütz., *Tabulæ Phycolog.* vol. i. t. 94. fig. 1.

MONOSPI'LUS, G. O. Sars.—A genus of Lynceidæ (Entomostraca).

Char. Carapace of series of superimposed valves. Head depressed. No compound eye.

BIBL. Norman & Brady, *Monogr. Nat. Hist. Tr. Northumb.*

MONOSTE'GIA, D'Orb.; MONOTHALA'MIA, Schultze.—Instituted as an order; but one-chambered Foraminifera are found in most of the chief families, and therefore cannot constitute a separate group. Thus *Proteonina* (*Squamulina*), *Cornuspira* (Pl. 18. fig. 13), *Uniloculina* (Pl. 18. fig. 3), *Trochammina* (Pl. 18. fig. 14), *Saccammina*, *Astrorhiza*, *Lagena* (Pl. 18. fig. 22–27), *Ovulites*, *Orbulina* (Pl. 47. fig. 1), and *Spirillina* (Pl. 47. fig. 5) are either usually or constantly unilocular.

MONOSTRO'MA, Thuret.—A genus of Ulvaceæ (Confervoid Algæ), of which *M. bullosum* (*Ulva bullosa*, Roth) is the type, distinguished from *Ulva* by consisting only of a single layer of cells, and these being roundish (mostly grouped in fours), imbedded in an apparently homogeneous gelatinous membrane (Pl. 5. fig. 1 *a*). This plant is reproduced by zoospores formed from the cell-contents, and discharged by bursting of the cell-wall (fig. 1 *b*, *c*). They have four cilia.

Mr. Currey has described, under the name of *M. roseum*, a plant which we think scarcely referable here, but rather to MICROCYSTIS, Kütz.

BIBL. Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 225, pl. 21. figs. 1–4; *Note sur les Ulvacées, Mém. de la Soc. Scient. de Cherbourg*, ii. p. 1 (1854).

MONOSTY'LA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eye single, cervical; tail-like foot simply styliform; carapace depressed.

Four species: three, Ehrenberg; and one other, Gosse.

M. quadridentata (Pl. 35. fig. 11). Carapace yellowish, fore part of head deeply cleft into four horns. Aquatic. Length 1-120''.

BIBL. Ehr. *Infus.* p. 459; Gosse, *Ann. N. H.* 1851. viii. p. 200.

MONOTOS'PORA, Corda.—A genus of Dematiei (Hyphomycetous Fungi), of which one species has been found in England, growing on dead bark of the yew. *M. megalospora*, Berk. and Br. Filaments erect, simple, straight, nearly equal, articulated. Spores terminal, obovate, even, ·00133 to ·0014'' long. Fries regards this genus with doubt.

BIBL. Berk. and Broome, *Ann. N. H.* 2 ser. xiii. p. 462, pl. 15. fig. 11; Fries, *Summa Veget.* 497.

MONTAGNI'TES, Fr.—A genus of Hymenomycetous Fungi belonging to the division Agaricini, distinguished by the dry gills which project after the universal volva breaks off from the edge of the pileus.

One species occurs in the south of France and Algeria, another in Texas, and a third in Siberia, in dry sandy soil. They are ex-

tremely interesting as connecting Hymenomycetes with the Gasteromycetes.

BIBL. Fr. *Ep.* p. 241; *Fl. Alg.* t. 21. f. 2.

MONU'RA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes two, frontal; foot simply styliform. Carapace somewhat compressed and open beneath.

Two species.

M. dulcis (Pl. 35. fig. 12). Carapace ovate, obliquely truncate and acute behind; eyes distant. Length of carapace 1-280''.

BIBL. Ehr. *Infus.* p. 474.

MOOR'EA, J. & Kirkby.—A fossil Ostracod, known by its suboval, depressed valves, with raised margins. Found in Silurian and Carboniferous rocks.

BIBL. Jones & Holl, *Ann. N. H.* 4. iii. 225.

MORCHEL'LA, Dill.—A genus of Ascomycetous Fungi, distinguished by its stipitate receptacle, which is deeply folded and pitted.

Four species occur in this country, amongst which *M. crassipes* is the giant of the genus. The species are esculent, and largely imported. They are very abundant in some parts of India, especially in Kashmir. They often occur on cinder walks and burnt soil.

BIBL. Grev. *Sc. Crypt. Fl.* tab. 68. 89; Berk. *Outl.* t. 21. f. 5; Cooke, *Handb.* p. 655.

MORELS'.—Species of *Morchella*, Dill. (Ascomycetous Fungi), having a pileiform receptacle, with a ribbed and lacunose hymenium on the upper side, bearing *asci*.

MORPHIA. See ALKALOIDS, p. 30.

MORPHO, Fabr.—A genus of Exotic Lepidopterous Insects.

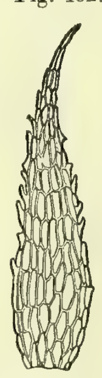
M. Menelaus. The scales from the wings of this beautiful insect are sometimes used as TEST-OBJECTS.

MOSSES, MUSCACEÆ.—This order of flowerless plants is distinguished from the Hepaticæ by the vegetative structure and by the sporanges. In one group alone (*Hypopterygieæ*) is the stem clothed with leaves, accompanied by amphigastria (stipule-like leaflets), in the manner of the foliaceous Hepaticæ (fig. 355, p. 395): and here the sporange is a stalked urn-shaped body, with a deciduous lid, and like those of the Mosses generally; and this Jungermannia-like leafy stem is *erect*, and not procumbent as in *Jungermannia* itself. In all other Mosses the leaves clothing the stem are arranged in a spiral order around the stem, so as to give the vegetative structure a very characteristic aspect. On the other hand, the Andræaceæ, which have a valvate capsule, have spirally-arranged leaves.

The stem of the Mosses is a slender thread-like or wiry structure, wholly composed of cellular tissue, without vessels; but the external layer has an epidermoid character, while the central portion is composed of elongated cells. In one section of the Mosses this stem terminates in a sporange, and these are called *Acrocarpous* Mosses; in others the sporanges spring from lateral branches, and the terminal bud of the stem elongates the stem year after year; these latter are called *Pleurocarpous* Mosses. In some of the genera the sporanges are borne terminally on short special branches, as in *Sphagnum*, *Mielichhoferia*, part of *Fissidens*, *Guembelia fontinaloides* (fig. 289, p. 353); these are termed *Cladocarpous*.

The leaves are of simple structure, usually composed of a single layer of cells, the forms of which are used as characters by systematic Muscologists. They are either all alike in a leaf, and filled with chlorophyll, and in these cases may be either *parenchymatous* (Pl. 38. fig. 19) or *prosenchymatous* (Pl. 38. fig. 20). In other cases two sorts of cells occur arranged in a peculiar way; some, smaller, containing chlorophyll, form a kind of network, the meshes of which are occupied by large uncoloured cells (see SPHAGNUM and LEUCOBRYUM).

Fig. 462.



Ephemerum serratum. Leaf. Magn. 50 diams.

The margins of the leaves are frequently serrated; and the upper surface is occasionally papillose, or covered with rough points. Many of them have one or more distinct nervules, composed of elongated cells, often not reaching the apex of the leaf.

The leaves often differ on different parts of the stem; and we hence have *radical*, *cauline*, and *perichætial* or involucral leaves, the last ordinarily forming a kind of rosette, in the midst of which the reproductive organs are produced. SCHISTOSTEGA exhibits two forms of stems, with two kinds of foliaceous structure: the stems which terminate in a sporange have leaves only at the upper part, and these arranged in eight rows standing crosswise on the stem, like ordinary leaves; the barren stems have two

rows of leaflets arranged in one plane on the stem, like the leaflets of a compound leaf (such as that of the Acacias) of Flowering plants. The stem-leaves of many genera exhibit wing-like structures, hair-like appendages, or peculiar forms of curvature (figs. 242–246, FISSIDENS); others, like

Fig. 463.

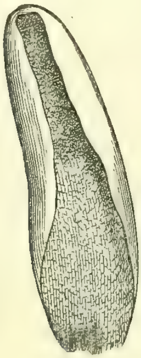


Fig. 464.

Barbula chloronotus.

Fig. 463. Leaf with cellular filaments at the tip. Magn. 30 diams.
Fig. 464. Leaf with cellular filaments crowded on the midrib, with an awn-like prolongation. Magn. 20 diams.

certain *Barbulæ* (figs. 463–466), have collections of cellular filaments on the upper side.

The outer leaves surrounding the repro-

Fig. 465.

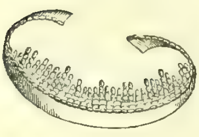
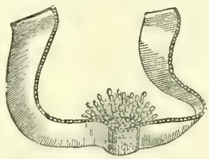


Fig. 466.



Barbula chloronotus.

Fig. 465. Cross-section of 463. Magn. 50 diams.
Fig. 466. Cross-section of 464. Magn. 50 diams.

ductive organs are called *perichætial*, and sometimes they form the only envelopes; sometimes, however, a few small leaves, differing very much from the above, form the immediate envelopes of the archegones, and these *perigonial* leaves, forming the perigone, are developed *after* the reproductive organs themselves (as is the case also with the *perigone* of the Hepaticæ). The perigonial leaves either overlap and cover-in the reproductive organs, or they are keeled at the base and turned back above, so as to expose the organs of reproduction (POLYTRICHUM).

The young reproductive organs consist of *antheridia* and *archegonia* or *pistillidia*, which are found either together (fig. 467),

Fig. 467.

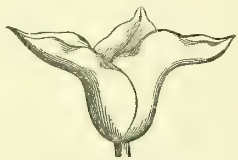
Fig. 468.

Bryum nutans.

Fig. 467. Inflorescence of antheridia and archegonia. Magn. 25 diams.
Fig. 468. Spermatozoids from antheridia. Magn. 600 diams. (The cilia omitted.)

or on different parts of the same plant, or on different individuals of the same species. To these structures the term *inflorescence* is applied. The antherids occur either with the archegones in one perigone (fig. 467) or in the axils of the upper leaves of the stem, which terminates in a perigone containing archegones; or they have a special perigone (fig. 469), either on the same plant, or on a

Fig. 469.



Mnium arcticum.
Antheridial inflorescence.
Magnified 25 diameters.

different one from that which bears the archegones. The antherids are globular, oval (fig. 467), or elongate membranous sacs composed of cellular tissue, filled with minute cellules, which escape by the bursting of the apex of the sac; and these cellules exhibit a fibre coiled in their interior, which circulates rapidly, even before the expulsion from the antherid, and after a time breaks out of its cellule (fig. 468, and Pl. 32. fig. 33), and moves rapidly round

in the water under the microscope (see ANTHERIDIA). The antherids are generally accompanied by cellular filaments which have received the name of *paraphyses* (fig. 23, p. 55); no physiological office is attributed to these; but the antherids are regarded as male organs.

The *archegone* of the Mosses (figs. 30, 31 (p. 68), 467), like that of the Hepaticæ

Fig. 470.

Fig. 471.

Fig. 472.

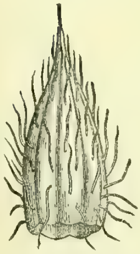


Fig. 473.

Fig. 470. Coscinodon pulvinatus. Capsule enclosed in the calyptra, with the vaginule below. Magn. 10 diams.
Fig. 471. Orthotrichum Hutchinsii. Capsule covered by the calyptra, with the vaginule below. Magn. 10 diams.
Fig. 472. Ditto. Calyptra. Magn. 25 diams.
Fig. 473. O. stramineum. Vaginule. Magn. 25 diams.

(excepting *Anthoceros*), is a flask-shaped cellular case, the epigone containing an *embryonal cell* at the bottom of its cavity. This embryonal cell becomes gradually developed by cell-division into a conical body elevated on a stalk, which at length tears away the walls of the flask-shaped epigone by a circular fissure, and carries the upper part upwards as a hood, while the lower part remains as a kind of collar round the base of the stalk (figs. 470–472); the latter is termed the *vaginula* (fig. 473); the cap-like portion carried upwards on the sporange is called the *calyptra* (figs. 470–472). The *sporange*, elevated more or less by the development of its stalk (*seta* or *peduncle*), is gradually converted by internal changes into a hollow urn-like case, usually with a stalk-like column (*columella*) running up its centre (figs. 50 (p. 82), 475), the space

Fig. 474.

Fig. 475.

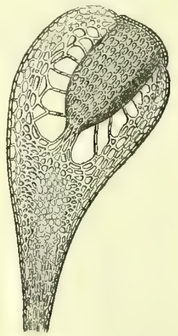


Fig. 474. Tayloria serrata. Dimidiate calyptra. Magn. 25 diams.
Fig. 475. Funaria hygrometrica. Section of young capsule, showing the columella. Magn. 50 diams.

between the central column and the side walls becoming filled with free *spores*, which are minute cells with a double coat, the outer of which exhibits elegant markings (see SPORES). In some cases this hollow case does not burst naturally, but the spores escape by its decay (ASTOMUM, fig. 50). In the ANDRÆACEÆ (fig. 11, p. 39) the sporange bursts by vertical slits, so as to be divided into valves, like the Jungermannieæ, and there is no *column* in the sporange here; but the valves do not separate at their summits, and the character of the leafy stem at once distinguishes these Mosses from the Hepaticæ. The ordinary course, however, in the Mosses is the formation of a horizontal slit near the top of the sporange, so that the upper part falls off like a lid (*operculum*, fig. 479).

The sporange of the Mosses exhibits a very complex anatomical structure, which we have not space to enter into very minutely here: it will suffice to state that the lower part next the peduncle is sometimes enlarged into a thickened mass, called the *apophysis*; sometimes the peduncle is very long, sometimes very short (*Phascum*, fig. 478) so that the sporange is hidden in the perichæte; finally, the mouth may either exhibit a smooth edge (fig. 479), or a single (figs. 476, 477) or double (figs. 483, 484) fringe of very variously constructed teeth, which are of great service in discriminating the genera. When the mouth of the sporange is naked, the Mosses are called *gymnostomous*, when furnished with only a single row of teeth *haploperistomous*, when with a double row *diploperistomous*. When a double peristome exists, the outer consists of *teeth*, the inner of *processes* or *cilia* (fig. 483) or of both (*Bryum*). The teeth sometimes arise directly from the mouth of the sporange, sometimes are seated on a basal membrane, sometimes connected together irregularly (FUNARIA, fig. 259, p. 329), or by regular bars (GUEMBELIA, fig. 291, p. 353), or the whole of the inner circle may be conjoined entirely (BUXBAUMIA, fig. 93, p. 120) or at the tips (fig. 480) into a membrane, or by a number of cross bars into an open trellis (fig. 484). The outer rows of teeth are continuations of the inner layers of tissue of the sporange (fig. 481); where an inner circle occurs they are continuations of the spore-sac; the outer wall of the sporange is, as it were, continued by the *operculum*. Ordinarily these do not separate directly from each other when the lid falls off, since one or several layers of elastic cells, forming a ring (*annulus*, fig. 482) round the mouth, split out from between the sporange and its lid, and cause the latter to fall off.

Fig. 476.

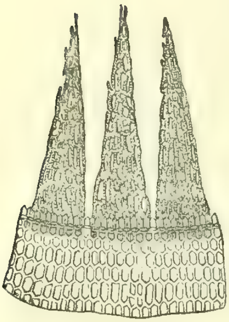


Fig. 477.

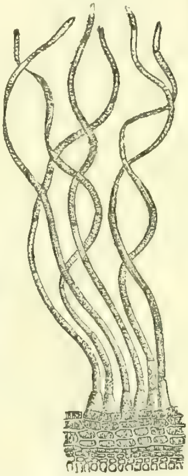


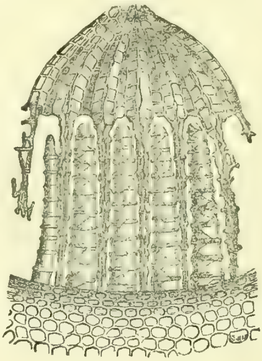
Fig. 476. Coscinodon pulvinatus. Fragment of peristome. Magn. 100 diams.
Fig. 477. Barbula flavipes. Fragment of peristome. Magn. 100 diams.

Fig. 478.

Fig. 479.

Fig. 478. Phascum serratum. Sessile sporange enclosed by few leaves. Magn. 15 diams.
Fig. 479. Pottia truncata. Operculum separating from the sporange. Magn. 10 diams.

Fig. 480.



Cinclidium arcticum.
Part of double peristome, the inner processes united into a plaited membrane in the centre.
Magnified 100 diameters.

The spores are developed in a distinct spore-sac, which has one layer next the wall

of the capsule, and an inner layer next the columella. The top of the columella expands into a kind of pseudo-operculum in

Fig. 481.

Fig. 482.

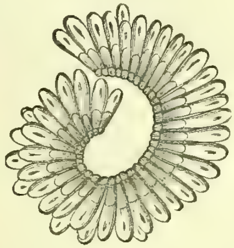


Fig. 483.

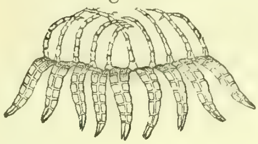


Fig. 481. Racomitrium fasciculare. Section of margin of sporange, with a tooth of the peristome. Magn. 100 diams.
Fig. 482. Bryum cæspiticium. Annulus. Magn. 100 diams.
Fig. 483. Orthotrichum diaphanum. Portion of double peristome, the outer composed of teeth, the inner of cilia. Magn. 50 diams.

Polytrichum. In Phascaceæ the columella is absorbed.

Allusion has been made to the sexual import of the antherids and archegones; and attention must be directed to the peculiar phenomena exhibited in the reproduction

Fig. 484.

Neckera antipyretica.
Double peristome, the inner composed of teeth united by cross bars, forming a trellis.
Magnified 100 diameters.

of the Mosses. The *embryo-cell* of the *archegonium* appears to be fertilized by the spiral filaments produced by the *antheridia*; the result here is not the production of a simple plant, but of a sporange or *fruit* which produces a number of spores, each of which may grow up into a new plant.

The Mosses exhibit a variety of forms of vegetative multiplication. The lower part of the stem often sends out horizontal branches, which root and produce buds (fig. 485), from which arise new leafy stems;

Fig. 485.

Polytrichum undulatum.
Creeping filaments with innovations.
Magnified 5 diameters.

and in this way patches of moss frequently increase to a great size. They also produce confervoid filaments, which exhibit tuberous thickenings, a form of *gemmæ*

Fig. 486.

Fig. 487.

Orthotrichum phyllanthum.
Leaves with gemmæ at the tips.
Magnified 25 diameters.

(figs. 488, 489), which may be detached from each other like bulbils, so as to pro-

pagate the plants without any sexual reproductive organs.

Gemmæ or minute cellular tubercles, capable of development into new plants, are likewise met with in other situations, as in the axils of leaves, on the surface, the margins (fig. 490), or at the tips (figs. 486, 487) of the leaves or the stems (fig. 491): these are formed of only a few cells at the time when they fall off, and illustrate well the independence of the individual cells forming the organs of these plants, where, under peculiar circumstances, a single cell of the tissue may be developed so as to lay the foundation of a new plant.

Besides these, small confervoid filaments form at the base of the stem, from which gonidia-like bodies separate; and zoospores like those of Algæ are formed from the chlorophyll-utricles of these filaments.

Portions of the protoplasmic substance of the elongated cells pass into an amœboid condition, resembling that of the gonidia of *Volvox*. The protoplasm first detaches itself from contact with the cell-wall, and collects into ovoid masses of various sizes; these gradually change their colour to red or reddish brown, subsequently, however, becoming almost colourless; and they protrude and retract processes exactly after the manner of *Amœba*, occasionally elongating themselves into an almost linear form, and travelling up and down in the interior of the tubular cells. The movement subsides gradually, the masses of protoplasm then returning to their ovoid form. But their exterior subsequently becomes invested with minute cilia, by which they are kept in constant agitation within their containing cells. Dr. Braxton Hicks, F.R.S., from whose researches this notice has been taken, has not traced their further life-cycle (Hicks, *Qu. Mic. Jn.* 1862, 96).

In the following arrangement of the Mosses we follow C. Müller. The order Muscaceæ is first divided into two suborders according to the habit of growth:

1. **ACROCARPI.** Mosses with the fruit-stalk terminating the stem, or short special branches (Cladocarpi).

2. **PLEUROCARPI.** Mosses with the fruit-stalk produced only from lateral buds.

Synopsis of the Families.

ACROCARPI.

* **Schistocarpi.** *Capsule without a lid (operculum), opening by longitudinal fissures.*

Fig. 488.

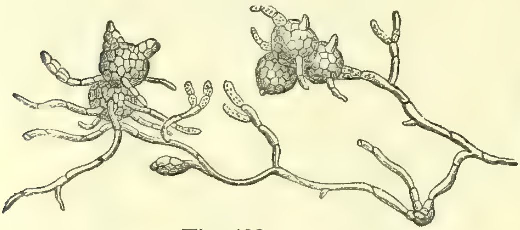
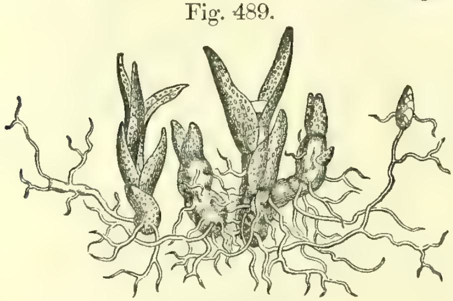


Fig. 489.



Hedwigia ciliata.
Creeping filaments with tuber-like gemmæ.
Fig. 488, magnified 50 diameters.
Fig. 489, magnified 20 diameters.

Fig. 490.

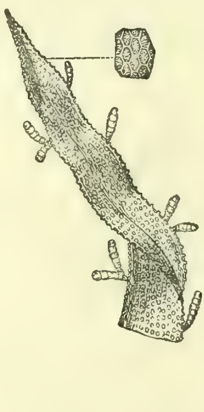


Fig. 491.

Fig. 490. Orthotrichum Lyellii. Leaves with marginal gemmæ. Magn. 50 diams.

Fig. 491. Aulacomnion undulatum. Gemmæ in the place of the capsule. Magn. 20 diams.

I. ANDRÆACEÆ. Capsule splitting into four valves.

** **Cleistocarpi.** *Capsule without a lid, bursting open irregularly.*

II. BRUCHIACEÆ. Cells of the leaf (*areolation*) parenchymatous, looser at the base, not papillose, dense.

III. PHASCACEÆ. Areolation of the leaf parenchymatous, dense, filled with chlorophyll, more or less papillose.

IV. EPHEMEREÆ. Areolation of the leaf parenchymatous, everywhere lax, not papillose.

*** **Stegocarpi.** *Capsule bursting by a lid.*

1. Distichophylla. *Leaves arranged in two straight rows.*

a. Leaves regularly vertical.

V. SCHISTOSTEGEÆ.

b. Leaves regularly subvertical.

VI. DREPANOPHYLLEÆ.

c. Leaves horizontal.

VII. DISTICHIACEÆ. Areolation of the leaves parenchymatous, minute; leaves without appendicular laminæ.

VIII. FISSIDENTEÆ. Areolation of the leaves parenchymatous; leaves produced into appendicular laminæ at the back and point.

2. Polystichophylla. *Leaves arranged in three or more straight or alternating rows.*

a. Leaves exhibiting narrow green cells, forming a reticulation between larger diaphanous cells.

IX. LEUCOBRYACEÆ. Leaves composed of several layers of columnar, empty, parenchymatous cells; the 'intercellular' green cells three- to four-angled, interposed between the empty cells in a single curved row.

X. SPHAGNACEÆ. Leaves composed of a single stratum of empty prosenchymatous cells, with intercellular green cells interposed between all the empty cells. Cladocarpous, branches fasciculate.

b. Leaves without 'intercellular' cells.

a. *Leaves not papillose.*

1. Loosely areolated.

XI. FUNARIOIDEÆ. Areolation of the leaf parenchymatous, lax, containing much chlorophyll.

XII. DISCELIACEÆ. Areolation of the leaves rhomboid-prosenchymatous, destitute of chlorophyll, empty, fuscescent.

XIII. BUXBAUMIACEÆ. Areolation of the leaf hexagonal or polygonal, very minute, dark-coloured, destitute of chlorophyll.

2. Densely areolated.

XIV. MNIOIDEÆ. Areolation of the lea in parallelograms at the base, round-hexagonally parenchymatous towards the apex; very full of chlorophyll, or more frequently thickened (very rarely papillose).

XV. BRYACEÆ. Areolation of the leaf prosenchymatous, ordinarily rhomboidal, abounding with chlorophyll.

XVI. DICRANACEÆ. Cells of the leaf prosenchymatous, very often intermixed with parenchymatous cells (rarely scabrously papillose), alar basilar cells ordinarily crowded and ventricose, or flat and much more loosely reticulated than the upper cells.

XVII. LEPTOTRICHACEÆ. Cells of the leaf rhombic at the base, rectangular or both mixed further up, smooth, without proper alar cells.

b. *Leaves papillose.*

XVIII. BARTRAMIOIDEÆ. Cells of the leaves parenchymatous, square, ordinarily nodulose or scabrous with papillæ at the transversal sides, never opaque.

XIX. POTTIOIDEÆ. Cells of the leaves parenchymatous, square, ordinarily covered on all sides with papillæ above the base, but smooth and pellucid at the base.

XX. DIPHYSCIACEÆ. Leaves of two kinds: the cauline with the cells densely hexagonally parenchymatous, abounding with chlorophyll, the perichætial leaves with the cells destitute of chlorophyll and more loosely reticulated.

PLEUROCARPI.

1. Distichophylla. *Leaves arranged in two opposite rows.*

XXI. PHYLLOGONIACEÆ.

2. Tristichophylla. *Leaves arranged in three rows, appearing like three, erect, of two forms.*

XXII. HYPOPTERYGIACEÆ. Cells of the leaf everywhere prosenchymatous, equal.

3. Polystichophylla. *Leaves arranged in four or more rows.*

XXIII. MNIADELPHACEÆ. Cells of the leaf parenchymatous, Mnioid.

XXIV. HYPNOIDEÆ. Cells of the leaf prosenchymatous, rhombic or rounded.

The Bog-Mosses, Sphagnaceæ, noticed in the classification, are remarkable microscopic objects from the nature of their leaves and reproduction. In the leaves, the chlorophyll-bearing cells are slender and elongated, and are connected in a kind of network in the interstices between large empty cells, whose walls are strengthened by a spiral fibre; this structure causes the whitish or yellowish-green colour peculiar to them and a few other similarly organized mosses. The branching is fasciculate. The antheridia much resemble those of *Jungermannia*, being globose, stalked bodies, and not sessile tubular sacs. There appears to be some peculiarity in their spores, since they have been observed to occur in some cases of more than the ordinary size, and fewer of them in a capsule.

Bibl. Hooker, Taylor, and Wilson, *Bryologia Britannica*; Bruch and Schimper, *Bryol. Euro.*; Schimper, *Coroll. Bryol. Euro.* 1855; *Flora*, 1856, p. 681; Hedwig, *Theoria generat.*; Bridel, *Bryol. Universa*; Müller, *Syn. Musc. frond.*; Dillenius, *His. Musc.*; Lanzius-Beninga, *Nova Acta*, xxii. p. 555; Hofmeister, *Vergleich. Untersuch.* Leipzic, 1837; *Ber. d. Sächs. Gesell. d. Wiss.* April 1854; *Flora*, 1855. p. 434; Valentine, *Linn. Trans.* xviii. p. 499; Hicks, *Linn. Trans.* xxiii. (1862), p. 567; Braithwaite, *Qu. Mic. Jn.* passim.

MOTH, CLOTHES. See Tinea.

MOTHER CELL, or Parent cell, is the term commonly applied to the cell in the interior of which a new generation of cells is developed.

MOTHER-OF-PEARL. See Shell.

MOTION AND MOVEMENT OF CELLS.—Some notice of these physiological peculiarities of animal cells may be seen in the articles Inflammation and Migration of cells, and also under Cilia and Pigment cells; and it is not necessary to refer to the movement of cells which is produced by fluid-currents like those of the blood. Cells of many kinds alter in shape and move irrespectively of pressure and currents, and are said to do so spontaneously; the motion of their molecules, however, belongs to the phenomena of life. After the ovum or germ is fertilized, and before the process of cleavage sets in (see Ovum), it undergoes certain automatic changes of form. The freshly deposited ova of the toad have at first several facets, but they subsequently become spherical; and Stricker has shown that the yolk-cells of the trout undergo amœboid movements, *i. e.* contraction and dilatation. Similar phenomena occur in the ova of the Bird and Rabbit. All the cells which migrate not by the force of currents, but by their inherent power of contractility and cohesion to surfaces, necessarily change their form—are amœboid in the nature of their alteration of shape and movements. Accompanying the change of form in some simple organisms which must be regarded as cells, is a remarkable movement of their protoplasm, without or with motion or change of place of the animal. The granules in the protoplasm of the threads or pseudopodia of the Foraminifera or Gromida stream with a gliding motion over the stationary sarcode; and accidentally included matters are carried on by the current. They frequently become stationary, and turn round and continue the opposite course. This movement is either continuous or occasional. The anterior epithelium of the cornea, and the corneal tissue itself, possess cells which exhibit the simplest kind of automatic movement; they move in order from before backwards. But in the more decided movement of the white blood-corpuscles there is a clinging to the tissues, a projection of parts of the protoplasm, a retraction of others, and a sliding, streaming movement onwards. These phenomena are probably increased by heat, and must not be confounded with molecular motion, or that produced by minute cilia; yet they are part of the same process which evolves ciliary motion, for the cilia move in two manners. Either they bend towards their supporting cell, and then return to bend in the opposite direction in obedience to this inherent contraction of protoplasm; or after bending in one direction the force ceases to act, and they return to their original position by virtue of the elasticity of the mass. The motion is essentially independent of special structure, is spontaneous and automatic to a degree, and therefore resembles that of the *Amœba*, the migrating corpuscle, and the streaming sarcode of the Rhizopoda. The peculiar cells, with processes, of connective tissue appear to enter the blood capillaries of the lymphatic system, and to escape through the protoplasmic wall; and the large granule spheres met with in exudation within serous membranes have processes which probably enable them to include granule after granule by amœboid motion. That which is understood by "life," and

also the existence of certain physical conditions—heat, liquidity, and abundance of assimilative matter—are necessary for the production and perpetuation of these motions and movements. In the vegetable kingdom, the phenomena of ROTATION in cells is remarkable (see ROTATION IN CELLS); but there are motions in the sarcode of plants, inducing change of shape, which are very decided, and others which have to do with the cell-growth, besides those which enable part or the whole of an organism to change its place irrespectively of currents. As in the animal kingdom the movements of spermatozoa are produced by the contractility and elasticity of cilia-like structures, so in the vegetable world the activity of spores and spermatozoids is due to corresponding attributes in a structureless tissue, and which probably has the same chemical and physical composition as that gifted with true amœboid movement. It is necessary to admit such movement as is noticed in some Fungi as amœboid; and the strange motions of the Oscillatoriæ are clearly due to the slight change in form of the protoplasm of some of the cells.

BIBL. General works on Histology and Physiology.

MOUGEOTIA.—A genus of Zygnemaceæ (Confervoid Algæ), distinguished by the conjugation of the filaments taking place without the formation of transverse processes, the conjugating filaments being geniculately bent. There is still obscurity as to the mode of reproduction of the plants of this genus. According to Vaucher, a spore is formed in one of the conjugating cells, without transfer of contents, and this, germinating *in situ*, breaks out from the parent cell. This account is probably correct as far as it goes, but does not explain fully the development of the spores. Hassall says the plants are reproduced by zoospores; this has been confirmed by Kützing, who, together with Itzigsohn, has observed the formation of small rounded resting-spores in the joints, which underwent segmentation and developed a number of smaller cells, the ultimate fate of which was not observed. All this tends to prove that the reproduction agrees with that of *Spirogyra*, where we have:—1. large conjugation-spores, sometimes germinating *in situ*, producing in some cases new filaments, in others zoospores; 2. zoospores produced immediately from the contents; and 3. what appeared to be encysted forms of these (see SPIROGYRA).

M. genuflexa, Ag. (fig. 139, p. 193). The cells are about 1-720″ in diameter in large specimens (*M. major*, Hass.), and about three or four times as long; in smaller specimens (*M. genuflexa*, Hass., *M. gracilis*, Kutz.) the diameter is about 1-200″, the length of the cells five or six times as great.

In fig. 139 the lowest filament does not belong to the genus; but the method of conjugation of *Mougeotia* is seen in the one above.

M. lævis, Archer, is an Irish form.

BIBL. Vaucher, *Conf. d'eau douce*, p. 79, pl. 8; Hassall, *Brit. Fr. Alg.* p. 171, pl. 40; Kütz. *Sp. Alg.* p. 43; *Tab. Phyc.* v. pls. 1–3, and 36; Itzigsohn, *Bot. Zeit.* xi. p. 681 (1853); Rabenh. *Fl. Eur. Alg.* iii. 255; Archer, *Qu. Mic. Jn.* 1867.

MOULDS and MILDEWS. — These names are generally applied indifferently to a multitude of Hyphomycetous, Physomycetous and Coniomycetous Fungi; but some of the more common ones are especially distinguished. Thus ordinary 'blue mould' of cheese, &c. is ASPERGILLUS *glaucus*; another still more common blue or green mould is PENICILLIUM *glaucum*; various species of OIDIUM and ERYSIPHE are known as the mildews of the Hop, Vine, Rose, &c. The mildew of wheat is PUCCINIA *graminis*.

MOUNTING. See PRESERVATION.

MOUSE, HAIR OF (Pl. 1. fig. 3; Pl. 22. figs. 27, 28). See HAIR OF ANIMALS and TEST-OBJECTS.

MOUTH. — The mucous membrane of the mouth, which becomes continuous with the skin at the lips, is furnished with very numerous conical or filamentous papillæ resembling those of the skin, sometimes simple, at others branched, and a number of mucous glands.

Its epithelium is of the pavement kind, consisting of several layers of delicate cells; these are roundish in the deeper, flattened and polygonal in the superficial layers.

The glands, distinguished, according to their situation, as the labial, the buccal, and the palatal glands, are rounded, about 1-36 to 1-6″ in size, and open by short excretory ducts into the mouth. They consist of glandular lobules enveloped in areolar tissue with elastic fibres, the whole being surrounded by a firmer portion or capsule, and a branched duct. The lobules are composed of a number of convoluted canals or lobular ducts, with simple or compound cæca or glandular vesicles, each consisting of a

basement membrane, and a single layer of angular epithelial cells. The latter separate very readily; and then the cæca appear filled with a granular mass.

Fig. 492.

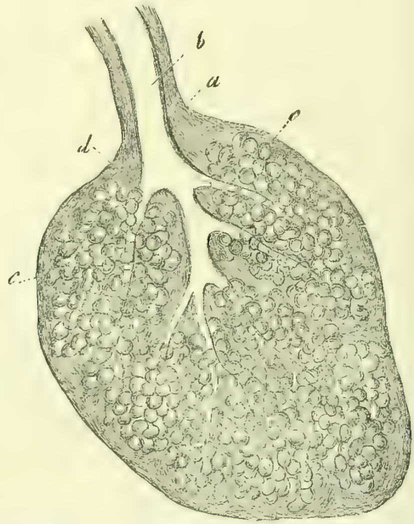
Epithelial cells of the mucous membrane of the human mouth: *a*, large, *b*, smaller cells; *c*, one with two nuclei.

Magnified 350 diameters.

The ducts of the lobules have a coat of areolar tissue, with networks of fine elastic fibres, and a single layer of cylindrical epithelial cells.

The mucous liquid of the mouth contains, in addition to detached epithelial cells, very transparent corpuscles, about 1-2000 to 1-1500″ in diameter, consisting of a delicate cell-wall, a nucleus, with a number of minute moving molecules. We have figured these among the TEST-OBJECTS (Pl. 1. fig. 5). They are called mucous or salivary corpuscles. Kölliker regards them as a form of exudation corpuscles: and this view is probably correct; for they may occur in the secretion of any mucous surface, and have no special connexion with the salivary

Fig. 493.



Human racemose mucous gland from the floor of the cavity of the mouth. *a*, areolar coat; *b*, excretory duct; *c*, glandular cæca; *d*, lobular ducts.

Magnified 50 diameters.

Fig. 494.

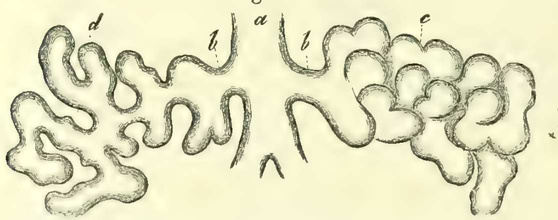
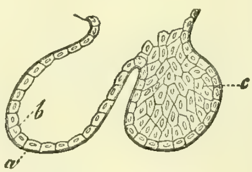


Diagram of two lobular ducts of a mucous gland. *a*. common duct; *b*, lobular branch; *c*, glandular vesicles *in situ*; *d*, the same separated, and the ducts unfolded.

Magnified 100 diameters.

Fig. 495.



Two glandular vesicles of a human cemose mucous gland. *a*, basement-membrane; *b*, epithelium, side view; *c*, the same in surface view.

Magnified 100 diameters.

glands: we have found them in myriads in the urine.

The secretion of the mouth frequently contains very slender filaments of a fungus (LEPTOTHRIX), with species of *Monas*, E., and of *Vibrio*.

BIBL. Kölliker, *Mikr. Anat.* ii.; Sebastian, *Rech. Anat. s. l. Gland. Labial.*; W. Webb, *Qu. Jn. Med. Sci.* 1857; Ward, *Todd's Cyclop. Anat.* &c.; E. Klein *in Stricker, Hum. & Comp. Hist. Syd. Soc.* vol. i. *Power's Tr.*

MUCED'INES.—A family of Hyphomycetous Fungi, forming moulds and mildews upon living or decaying animal or vegetable substances, and contributing to their decomposition, characterized by a flocculent mycelium bearing erect, continuous or septate, simple or branched, tubular pellucid filaments, terminating in single spores or strings of spores, which soon separate from each other, and lie among the filaments of the mycelium. This tribe includes a number of the most interesting of the microscopic fungi, noted for their destructive influence upon organic bodies which they attack. The species of *Botrytis, Oidium*, &c. spread with wonderful rapidity as mildews over the herbaceous parts of vegetables and moist vegetable substances generally; in the former situations their spores enter the stomata, their mycelia ramifying among the subjacent cells, and carrying decomposition and decay into all the soft structures. They are most abundantly developed in a close, damp atmosphere. The mycelia of other kinds, as of PENICILLIUM, growing in liquids containing organic matter, or upon decaying vegetable substances, produce remarkable chemical decompositions, causing a fermentation of the medium in which they exist.

See PENICILLIUM and FERMENTATION.

Synopsis of British and nearly allied Genera.

A. Fertile filaments (*pedicels*) simple or branched, terminating in single spores or a very short row.

* *Spores simple.*

1. *Botrytis.* Pedicels erect, septate, branched; branches and branchlets septate; spores solitary, on the tips of the branchlets, which are either racemose, umbellate, cymose (*Polyactis*), paniculate, verticillate (*Acrostalagmus*), spicate (*Haplaria*) or capitate.

2. *Peronospora.* Like *Botrytis*, but the pedicels without septa; often producing resting-spores.

3. *Verticillium.* Pedicels erect, septate, with whorled branches terminating in a solitary spore or a short row of spores.

4. *Acremonium.* Pedicels short, subulate, branches from a horizontal filament, bearing single smooth spores.

5. *Zygodesmus.* Like the last, but with echinulate spores.

6. *Oidium.* Pedicels simple, short, erect, clavate, septate, bearing usually one, sometimes two more or less oval spores.

7. *Fusidium.* Pedicels very short, pulvinate. Spores elongate, fusiform.

8. *Menispora.* Pedicels erect, septate, bearing fusiform or cylindrical spores, at first joined in bundles.

9. *Sceptromyces.* Pedicels erect, geniculate, verticillately branched; branches short, racemose; spores in grape-like bunches.

** *Spores septate.*

10. *Brachycladium.* Pedicels branched above, septate, moniliform; branches and branchlets forming a sporiferous capitulum; spores transversely septate.

11. *Trichothecium.* Pedicels interwoven in tufts, the central erect, fertile; spores acrogenous, didymous, free, commonly loosely heaped together.

12. *Cephalothecium.* Pedicels simple, continuous, bearing a terminal head of didymous spores.

B. Erect filaments (*pedicels*) terminating in strings of spores.

* *Spores simple.*

13. *Penicillium.* Pedicels erect, septate, penicillately branched above; branches and branchlets septate; strings of spores attached to the tips of the branches.

14. *Sporotrichum.* Pedicels erect, simple or slightly branched, septate and articulate, articulations remote, inflated; spores simple, usually found collected in heaps among the filaments.

15. *Briarea.* Pedicels erect, septate, with terminal moniliform chains of spores, crowded into a head.

16. *Gonatorrhodon.* Pedicels erect, septate, with chains of spores in a terminal head and in whorls at the joints.

** *Spores septate.*

17. *Dendryphium.* Pedicels erect, sep-

tate, unbranched; strings of spores attached in a bunch to the apex; spores septate.

18. *Dactylium.* Pedicels erect, septate, branched above; strings of septate spores attached singly or in pairs to the apices of the branches.

C. Fertile filaments (*pedicels*), inflated at the tips or at various points in their length, with projecting points or warts on the inflations bearing

* *Simple spores.*

19. *Aspergillus.* Pedicels continuous, erect, simple filaments, inflated into a little head at the summit, bearing moniliform chains of spores, crowded into a capitulum.

20. *Rhinotrichum.* Pedicels erect, septate, sometimes sparingly branched, the apices clavate, cellular, bearing scattered points supporting simple spores.

21. *Papulaspora.* Pedicels short lateral branches from a creeping filament, terminating in cellular heads beset with simple spores on the areolæ.

22. *Rhopalomyces.* Pedicels erect, not septate, terminating in cellular heads, with simple spores on the areolæ.

23. *Stachylidium.* Pedicels erect, articulated, whorled-branched above; branchlets geniculate and articulate; spores subpedicellate, accumulated in little capituliform heads inserted at the tips of the branches.

24. *Gonatobotrys.* Pedicels erect, septate, with joints swollen at intervals, the swollen joints bearing globular heaps of spores on short spines spirally arranged.

25. *Acmosporium.* Pedicels erect, septate, branched above; branches and branchlets forming a cyme, thickened at the apex, and furnished with globular capitules covered all over with points; spores simple, attached on the points of the capitules.

26. *Haplotrichum.* Pedicels erect, septate, terminating above in a continuous, simple, solitary, sporiferous head; spores simple.

27. *Actinocladium.* Pedicels erect, septate, umbellately branched at the summit; spores simple, accumulated at the tips of the branches.

28. *Botryosporium.* Pedicels erect, septate, with short spine-like branchlets above, spirally arranged, and terminating in four or five short points, which support globular heads of spores.

** *Spores septate.*

29. *Arthrobotrys.* Pedicels simple, septate, with joints swollen at intervals, the swollen joints clothed with spines bearing didymous spores, which are collected into globular heaps.

Some of the species are mere conditions of perfect Fungi, as *Hypoxylon* and *Claviceps*.

Bibl. See the genera.

MU'COR, Micheli.—A genus of Mucorini (Physomycetous Fungi), forming a common mould on paste, decaying fruits, or other vegetable matters. The general character is that of an interwoven mass of horizontal branched filaments, sending down little root-like ramules and pushing up erect fertile filaments (not septate), which branch at the base in a stoloniferous manner, and thus form loosely grouped tufts. At the summit of the erect filaments, a globular vesicle is formed, which soon becomes cut off by a septum. Its contents become divided into a large number of spores; and the septum at the base becomes meanwhile pushed up or protruded into the centre of the vesicle so as to form a kind of "core," called the *columella*. After a time the vesicle (*peridiole*) bursts and discharges its spores; the pressure of the turgid columella apparently hastens the bursting. The dehiscence takes place either by a circular

Fig. 496.

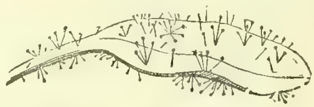


Fig. 497.

Mucor Mucedo.

(*Ascophora*-form.)

Fig. 496. Nat. size, growing on a leaf.

Fig. 497. Single fertile filaments, with the columella collapsed, and fallen like a cap over the end. Magn. 50 diams.

slit just above the base of the columella, leaving this alone, surrounded by a narrow ragged collar (*Mucor*), or the peridiole bursts above and disappears by solution, and the columella collapses upon the pedicel (*Ascophora*, fig. 497). The membrane of the peridiole of *M. Mucedo* (and perhaps of other species) is clothed with minute spines. The erect filament is sometimes simple, sometimes branched. It has been conjectured, though on what grounds is uncertain, that the columella may become converted into a second peridiole, by being shut off by a septum which is converted into a new columella.

It has been imagined that ACHLYA is only an aquatic form of *Mucor*, and this seems not improbable; however, the experiments we have made on this point have hitherto given negative results.

The species of *Mucor* described by authors are pretty numerous: but we think considerable allowance for variation should always be made in this genus. RHIZOPUS, Ehr. = *Mucor* when distinctly stoloniferous. It seems very doubtful whether HYDROPHORA should be separated from *Mucor*.

* *Fertile filaments simple.*

1. *M. Mucedo*, L. (figs. 496, 497). Mycelium byssoid, peridiole and spores globose, at first white, ultimately blackish. (This includes *Ascophora Mucedo*, Tode.) Extremely common. Sowerby, *Fungi*, pl. 378. fig. 6; Greville (*Ascophora*), *Sc. Crypt. Fl.* pl. 269.

2. *M. caninus*, Pers. Mycelium byssoid, peridiole globose, ultimately yellow or ferruginous; spore globose or elliptic. Very common on excrement of dogs and cats in wet weather. Grev. *Sc. Crypt. Fl.* pl. 305.

3. *M. fusiger*, Lk. Mycelium byssoid. Peridiole globose, ultimately black; spores spindle-shaped. On decaying fungi.

4. *M. clavatus*, Lk. "Mycelium byssoid. Clavate apices of the fertile filaments simply penetrating the globose peridiole; spores globose, at first white, then brown, at length black." On rotten pears. (Possibly only a state of *M. Mucedo* or the following.)

5. *M. amethysteus.* Mycelium thick, white, closely interwoven. Peridiole at first white, then pale yellow, then crystalline and pure violet, finally violet-black or brownish; "spore globose, filled with globose sporidioles (?)." Fertile filament 1-40″ high. On rotten pears with the foregoing.

6. *M. delicatulus*, Berk. Mycelium forming a thin velvety stratum. Very minute; fertile filaments short; peridioles globose, pale yellow; spores globose. On rotting gourds.

7. *M. succosus*, Berk. Mycelium forming small, pulvinate, yellow, spongy masses. Peridiole very minute, globose, yellow, at length olive; columella minute. On dead shoots of *Aucuba*. Berk. *Ann. Nat. Hist.* vi. pl. 12. fig. 15.

** *Fertile filaments branched.*

8. *M. ramosus*, Bull. Mycelium woolly. Fertile filaments racemose. Peridioles globose, yellow, then bluish-grey or reddish-brown. On rotting fungi. Bulliard, pl. 480. fig. 3.

9. *M. subtilissimus*, Berk. Mycelium creeping, filaments exceedingly slender. Fertile filaments branched, the short patent branches each terminating in a globose peridiole; spores oblong, elliptical. A mildew of onions. Berk. *Hort. Journ.* iii. p. 97. figs. 1–5.

BIBL. Berk. *Brit. Flora*, ii. pt. 2. p. 332; *Ann. Nat. Hist.* vi. p. 433; *Hort. Journal*, iii. p. 91; Fries, *Summa Veg.* p. 487; *Syst. Myc.* iii. p. 318; Fresenius, *Beitr. z. Mycologie*, heft 1, p. 4 (1850).

MUCORI'NI.—A family of microscopic Physomycetous Fungi, constituting the moulds, &c. common on most decaying vegetable and animal substances, consisting of a filamentous mycelium, forming flocks and clouds in or on decaying matters, bearing vesicles (on erect pedicels or sessile) filled with minute sporules, discharged by the rupture of the vesicles (*peridioles*). These plants correspond among the thecasporous Fungi to the Mucedines among the acrosporous or free-spored orders. The peridiole consists of the terminal cell of an erect filament, enlarged (like the head on a pin) into a globular vesicle. At first the cavity of this vesicle communicates with that of the pedicel; but a septum is soon formed; in some genera this septum is flat, in others projecting into the interior of the peridiole like the "punt" of a bottle, forming a hemispherical or cylindrical columella. While this columella rises in the peridiole, the latter becomes filled with spores, forming thus a polysporous sporange; and it bursts to let them escape.

The manner of bursting of the sporange and the form of the central column vary much, and afford generic characters. *Thelactis* presents a remarkable peculiarity: each filament terminates in a sporange containing a great number of spores, while at its base

it gives origin to whorls of branches, the terminal cells of which remain sterile.

Syzygites, as Ehrenberg first stated, exhibits a phenomenon of conjugation of its branches, like that of the Zygnemaceæ among the Algæ. (See SYZYGITES.)

Some observations have been published by De Bary, tending to show that the genus *Eurotium* only represents certain conditions of *Aspergillus*. From a recent examination of these plants, we have reason to believe that De Bary is mistaken in his conclusions; his account of the early development of the peridiole of *Eurotium* is certainly erroneous. *Eurotium* should properly stand among the PERISPORACEI. (See EUROTIUM.) In some cases the lower threads are enormously developed, where, from excessive moisture, the fruit cannot be produced. Two different forms of fruit occasionally occur in the same thread, as in *Ascophora elegans*.

Synopsis of British and allied Genera.

1. *Phycomyces*. Peridiole pear-shaped, separated from the apex of the erect pedicel by an even joint; opening by an umbilicus. Spores oblong, very large. Filaments cæspitose, tubular, continuous, and shining.

2. *Hydrophora*. Peridiole subglobose, membranous, dehiscent, at first crystalline, aqueous, then turbid, and at length indurated, persistent. Columella absent; spores simple, conglobated.

3. *Mucor*. Peridiole subglobose, separating like a cap (leaving an annular fragment attached) from the erect, simple, continuous pedicel, or bursting irregularly; columella cylindrical or ovate, spores simple.

4. (?) *Acrostalagmus*. Peridioles globose, with a columella; at the points of doubly verticillate branches from an erect pedicel.

5. *Ægerita*. Peridiole spherical, very fugacious; sporidia soon scattered like white meal over the grumous receptacle.

6. *Pilobolus*. Peridiole globular, separating like a cap from the short stalk composed of a single cell, attached on a unicellular ramified mycelium; columella conical; spores very numerous, free in the peridiole.

7. *Syzygites*. Filaments erect, simple, very much branched above, branches and branchlets di- or trichotomous, fertile branches forcipate, bearing pairs of opposite internal clavate branches, which subsequently coalesce.

8. (?) *Eurotium*. Peridiole cellular-membranous, sessile, at length bursting irregularly; spores produced by a central cellular nucleus which breaks up into numerous parent cells (*asci*), in which 4–8 minute spores are formed and finally set free; filaments of the mycelium radiating from the base of the peridiole.

Excluded genera. *Ascophora = Mucor*; *Thelactis = Mucor* ?; *Rhizopus = Mucor*.

MUCOUS CORPUSCLES. See MOUTH.

MUCOUS MEMBRANES.—Those internal canals and cavities of the body which open externally, as the alimentary canal, bladder, &c., are bounded by what may be regarded as internal prolongations of the skin, called mucous membranes.

They consist of four layers:—1, an innermost or epithelial layer, corresponding to the cutaneous epidermis; 2, a subjacent structureless basement membrane, which is not always separable and demonstrable or present; 3, a layer of variable thickness, consisting of areolar and elastic tissue, well supplied with blood-vessels and nerves, often containing numerous small glands, frequently furnished with conical or filiform processes termed papillæ or villi, and sometimes traversed by muscular fibres. These three layers form the proper mucous membrane; and are supported by, 4, an outermost submucous layer or coat, composed of the same elements as the last, but much more lax in structure, and frequently containing fatty tissue.

The mucous membranes are usually very vascular; and injected preparations of them are very beautiful, and to some extent characteristic.

The size and form of the epithelial cells are to a certain extent also characteristic, especially those of the uppermost layer; and a knowledge of the peculiar structure in individual cases is of use in determining the source of morbid mucous products mixed with epithelial cells.

See the special articles.

MUCUS.—Natural mucus contains no essential morphological elements. As ordinarily met with, it often, however, exhibits some epithelial cells, mucous corpuscles, and numerous granules; and the peculiar mucous matter has a striated or fibrous appearance, mostly produced artificially. The abnormal elements are principally those of inflammation.

BIBL. See CHEMISTRY, ANIMAL.

MUD.—The organisms found in mud are very numerous; they consist principally of

Diatomaceæ and other minute Algæ. The surface of mud is often covered with yellowish or greenish layers, composed almost entirely of these organisms. The most beautiful and most numerous forms of Diatomaceæ are found in the mud of sea-water, or that of tidal rivers. On exposing a bottle of mud and water to the light, they will rise to the surface of the mud, some adhering to the side of the bottle next the light, and can then be easily separated. The surface of freshwater mud frequently appears of a blood-red colour, from the presence of *Tubifex rivulorum.*

MUREX'IDE. See AMMONIA, PURPURATE OF, p. 34.

MURIATE OF AMMONIA. See AMMONIA, HYDROCHLORATE OF, p. 33.

MU'RIFORM PAREN'CHYMA.—The medullary rays of stems are composed of flattened six-sided cells which are placed one above the other in one or more rows, like bricks in a wall ; hence the term *muriform.*

MU'SA, Tournet.—A genus of Musaceæ (Monocotyledonous Flowering Plants), comprising the Bananas and Plantains. The fibro-vascular bundles of *Musa* afford examples of spiral vessels with numerous spiral fibres (see SPIRAL STRUCTURES). *Musa textilis* affords the fibre called Manilla hemp (see Pl. 21. fig. 7). See FIBROUS STRUCTURES.

MUS'CA, Linn.—A genus of Dipterous Insects, of the family Muscidæ.

Among the well-known species (all of which have been formed into new *genera*), we may mention:

1. *Musca domestica*, L., common house-fly. Third joint of antennæ thrice the length of the second ; style plumose, eyes reddish brown, front of head white, the rest black ; thorax blackish grey with four longitudinal black bands, abdomen blackish brown above, with blackish elongated spots, pale yellowish brown beneath.

2. *M. carnaria*, L. (*Sarcophaga*, Meigen), the flesh-fly. Antennæ feathery ; head golden-yellow in front, eyes reddish ; thorax grey, with black longitudinal lines ; abdomen black, with four square white spots on each segment ; all the body strewed with black hairs. Viviparous, 1–2″ long.

3. *M. Cæsar*, L. (*Lucilia*, Donov.). No spots, abdomen green, with a metallic lustre.

4. *M. vomitoria*, L. (*Calliphora*, Donov.), bluebottle or blow-fly. Head yellowish, golden or white, eyes brown ; thorax black ; abdomen shining blue with black stripes and long black hairs.

The larvæ are known as gentles. The ova or larvæ are deposited upon animal or vegetable substances, mostly in a state of decay, upon which they live.

Several parts of the species of *Musca* are of general microscopic interest,—as the proboscis (Pl. 26. fig. 29) with its two fleshy lobes (*c*), kept expanded by a beautiful and elastic framework of modified tracheæ ; the setæ or lancets (*b*), which are modified maxillæ, sometimes rudimentary, with their palpi (*a*) at the base ; the remarkable antennæ (Pl. 26. fig. 20) ; the elegant tarsus (Pl. 27. fig. 7 *a*), with its terminal spine, pulvilli (figs. 7, 8 & 9) and claws ; and the rudimentary wings (halteres, INSECTS, p. 421).

5. *Musca pumilionis* (*Chlorops*, Meig.) deposits its eggs in the young wheat-grain, which is consumed and destroyed by the larvæ.

Many other members of allied families of Diptera, commonly known also as flies, are of microscopic interest, on account of their oral setæ or lancet-like organs.

BIBL. Westwood, *Introd. &c.*; Macquart, *Hist. Nat. d. Ins. Dipt.*; Meigen, *Syst. Beschr. d. bek. eur. zweiflüg. Insect.*; Keller, *Gesch. d. gemein. Stubenfliege*; Suffolk, *Mo. Mic. Jn.* i. 331 ; Lowne, *on Fly.*

MUSCA'CEÆ. See MOSSES.

MUSCARDINE. — A disease in silk-worms, in which the whole of the sebaceous matter is exhausted, and the blood greatly altered, by a species of mould, *Botrytis bassiana*, which is perhaps too near *Botrytis diffusa*, Grev. A few of the spores placed on the back of a healthy silkworm are sufficient to impregnate the whole body. It takes its name from the resemblance of the diseased caterpillar to a peculiar kind of pastile.

BIBL. Balsamo, *Gaz. de Milan*, Juin 1835; *Bibl. It.* xxix. 1835; Robin, *Vég. Par.* p. 560; Guérin, *Journ. Séric.* 1849, 1850, 1851.

MUSCLE.—Muscular tissue forms the greater portion of the flesh of animals.

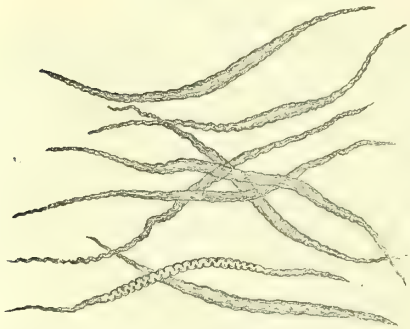
It occurs in two principal forms ; one of which is termed organic, unstriated, or unstriped muscle ; the other, voluntary, striated, or striped muscle.

Unstriated muscle.—This consists of more or less elongated, somewhat spindle-shaped, narrow fibres (p. 70, fig. 34), having the import of cells, and hence often called fibre cells. They are, however, solid. When

placed in serum, each contains an elongated nucleus and from two to four granules or nucleoli. The fibres are of variable length (from about 1-580 to 1-250″), and 1-5000 to 1-3500″ in diameter. They sometimes exist singly in the midst of areolar tissue; at others they are united into rounded or flattened bundles, and surrounded by an imperfect kind of sarcolemma, composed of areolar tissue with elastic fibres.

They occur most abundantly in the hollow viscera, as the stomach, the intestines, the bladder, and the uterus; but they also exist in other situations, as the spleen, trachea and bronchi, the dartos, the arteries, veins, and lymphatics, the prostate gland, fallopian tubes, urethra, villi of the small intestines, the skin, iris, and beneath the lung-pleura, &c.

Fig. 498.

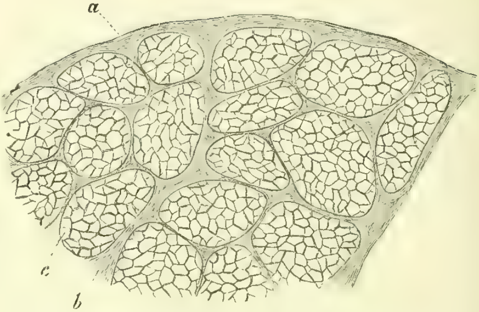


Unstriated muscular fibres from the œsophagus of a pig, after treatment with dilute nitric acid.

Magnified 10 diameters.

Striated muscle.—The structure of striated is more complex than that of unstriated muscular tissue. It consists of a number of very slender fibres, called fibrillæ, connected into bundles, termed primitive bundles or fasciculi, each of which is enclosed in a sheath or sarcolemma. The primitive bundles are again united into secondary and tertiary bundles, the whole being bound together by a connected mass of areolar and elastic tissue surrounding each of them, and forming the perimysium. This arrangement is best seen in a transverse section (fig. 499).

Fig. 499.

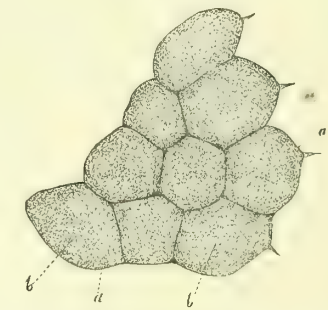


Transverse section of a portion of the sterno-cleido-mastoideus: *a*, outer perimysium; *b*, inner perimysium; *c*, primitive and secondary muscular bundles.

Magnified 50 diameters.

The primitive bundles are from about 1-1000 to 1-200″ in diameter, and of a rounded or polygonal form (fig. 500). Their surfaces are marked by a number of transverse striæ, which forms the most characteristic appearance of the tissue. They also exhibit irregular longitudinal striæ, which are the indications of the component fibrillæ (Pl. 17. fig. 35).

Fig. 500.



Transverse section of the muscular fibres or primitive bundles of the human gastrocnemius: *a*, sarcolemma and interstitial areolar tissue; *b*, section of fibrillæ and intermediate substance.

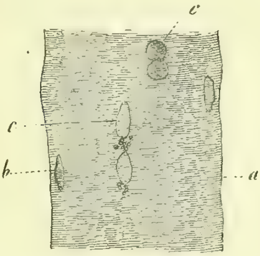
Magnified 350 diameters.

The sheath or sarcolemma, when separated from the muscular substance by treatment with water, acetic acid, and alkalies, in which it is insoluble, forms a structureless, transparent and smooth membrane. It is perhaps most easily seen in the muscle of fishes by simple dissection (Pl. 41. fig. 18). On its inner side are numerous spindle-shaped or lenticular nuclei (fig. 501).

The ultimate or primitive fibrillæ in man

are about 1-20,000″ in diameter, and each exhibits numerous regularly alternating light and dark portions (Pl. 17. fig. 36 *f*); the relative positions of the two may, however, be made to change by altering the

Fig. 501.



Portion of a primitive bundle treated with acetic acid: *a*, sarcolemma; *b*, single nucleus; *c*, twin nuclei surrounded by granules of fat.

Magnified 450 diameters.

focus. The ends of the fibrillæ are distinguishable in transverse sections of the primitive bundles; and their lateral margins are perfectly straight.

Different views have been taken of the structure of the fibrillæ, and, in fact, of the general structure of muscle. Thus the ultimate fibrillæ have been described as moniliform or beaded (Pl. 17. fig. 36 *c*); this appearance, however, arises from an optical illusion, connected either with imperfection in the object-glasses used, viewing the object in too much liquid, or the use of too low an object-glass, and too high an eyepiece.

Fig. 502.

A, a primitive bundle, magnified 350 diameters, partly separated into disks, side view. *B*, the same, rather more magnified, end view.

It often happens, especially when muscle has been kept in spirit, that it separates transversely into a number of flat disks (fig. 502); hence it has been viewed as consisting of these disks. Again, as under certain conditions it separates longitudinally into fibrillæ and transversely into disks, it has been supposed to consist of 'primitive particles' or 'sarcous elements' united end to end as well as laterally. We admit the existence of the primitive fibrillæ as original components of muscle, although there can be little doubt that the fibrillæ are not homogeneous, and of uniform constitution either chemical or physical. On carefully examining them at different foci, it is seen that those portions of isolated fibrils which appear dark when the margins of the fibrils are best in focus, are more highly refractive than the intermediate portions, as shown by the greater luminosity they acquire on altering the focus of the object-glass; and that this focal effect does not arise from a lenticular form of the parts is evident from the straight condition of the margins of the fibrils. Hence these more highly refractive parts probably constitute the proper muscular substance, connected in the direction of their length by a different kind of substance, which becomes brittle under the action of spirit, whilst the former does not; for the line of separation into the disks occurs through the less highly refractive portions. And that these compound fibrils naturally exist is shown by their being distinguishable in a primitive bundle without the use of reagents, or even of mechanical means.

It has also been supposed that the ultimate fibrils are composed of cells arranged end to end; and the appearance represented in Pl. 17. fig. 36 *a*, which is sometimes met with, might countenance this notion. But whenever it is seen, there is imperfect definition, from the presence of too much liquid, or some other cause; for we have never observed it when the object was properly arranged and examined.

There are other appearances exhibited by the fibrillæ which cannot at present be satisfactorily explained. Thus, sometimes each more highly refractive portion is divided by a dark line, indicating less refraction at that part (Pl. 17. fig. 36 *d*, taken at the elevated focus); at others the same part appears bounded at each end by a transverse dark line (fig. 36 *b*), or both parts are traversed mesially by a transverse dark line. In some instances we have noticed a very delicate constriction, which would account for these appearances; but the explanation of this we have failed to discover.

The dárk portions of the various fibrillæ of the primitive bundles being opposite to each other, gives rise to the coarser dark

striæ seen under a low power. But it often happens that by pressure or manipulation this natural relation is destroyed, the direction of the striæ altered, and sometimes those of one bundle are made to alternate with those of the next. Hence arises an appearance of transverse or spiral fibres (Pl. 17. fig. 35); but none such really exist in muscle.

Schäfer's views of muscular structure.—In *Dytiscus marginalis* the transverse bands are well seen, consisting of broader dim stripes alternating with narrower bright ones, which exhibit a transverse line of minute dots. Each disk of dim substance appears pervaded throughout by a number of excessively fine rod-shaped particles of uniform diameter, and rather darker in appearance than the substance of the disk they traverse. These particles are arranged closely and very regularly, with their axes in a direction more or less parallel to that of the fibre; they extend at either end into the neighbouring disks of bright substance, becoming somewhat less distinct as they pass into this, and finally terminating near its middle in an enlarged knobbed extremity, which appears as a minute dark dot. Each of these bodies is a *muscle-rod* consisting of a *shaft*, which is imbedded in the substance of the dim stripe, and of two enlarged extremities or *heads*, which are found near the middle of the bright stripe. It follows that there are as many series of muscle-rods as disks of dim substance in the fibre. Moreover each rod of any one series corresponds exactly with one in the next following series, their enlarged extremities almost meeting in the middle of the bright substance; this arrangement causes the appearance of a double row of dots running transversely across each bright stripe.

The muscle-rods are imbedded in a *ground-substance*; and this is bright and clear near the heads, and dim near the shafts of the muscle-rods. The brightness is an optical effect, produced by the presence of the globular heads; and when these are close together and in rows, transverse bright bands are determined.

The belief in the existence of alternating disks of different materials must be abandoned; and it is evident that although differently affected by light in the neighbourhood of the rod-head and of the rod-shaft, the ground-substance is homogeneous throughout.

This is proved, moreover, by the appearance of the fibre under polarized light; for the whole of the proper or ground-substance is anisotropous, but the muscle-rods are isotropous.

The unstriated and the striated muscular fibres have the same chemical composition.

In regard to the development of muscle, it appears that a muscular fibre proceeds from a cell which elongates and becomes fusiform, and at the same time increases in thickness; the nucleus then increases, and on its surface appears a mantle of longitudinal striæ.

The muscles are very vascular. The smaller branches of the vessels mostly run parallel to the primitive bundles in the perimysium, and anastomose by transverse or oblique branches.

They are also well supplied with nerves, about the termination of which there has been much difference of opinion.

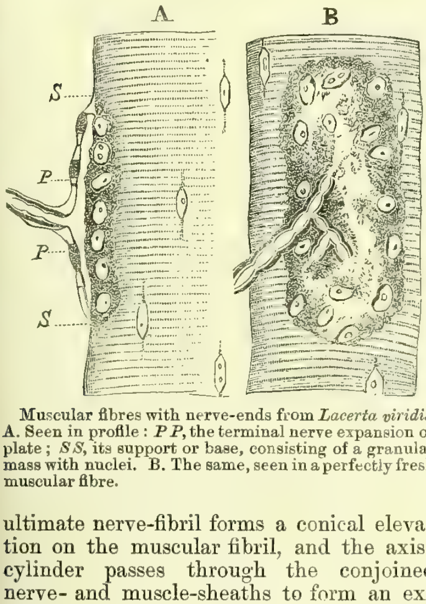
Lionel Beale insists that the ending of nerves in muscle forms no exception to his rule, "that in all cases the terminal distribution of nerves is a plexus, network, or a loop; and hence, in connexion with every terminal nervous apparatus, there must be at least two fibres."

Thus in insects a nerve-fibre consisting of many extremely fine fibrils passes on to the sarcolemma and becomes connected with it; but the nerve divides and gives off fibrils in different directions. A more or less conical mass exists where the nerve comes into final contact with the muscular fibril; but the axis-cylinders and other nervous elements do not simply merge into a mass of protoplasm and included nuclei, but break up into extremely fine ramifications which pass off in many directions. He asserts, also, that the nerve-fibres going to unstriped muscular fibres do not become organically connected with them, but the muscle-fibres lie in meshes of nerves.

On the other hand, Doyère discovered that in Tardigrada the nerve applied itself to the muscular fibre by means of a conical enlargement; and as in this animal these structures are without sheaths, the nervous and muscular elements are in direct contact. In *Hydrophilus piceus*, the nerves break up into numerous branches, and spread over the muscles; and finally the sheath of each terminal nerve becomes continuous with the sarcolemma by means of a funnel-shaped process. The nervous matter passes down this process, and divides usually into two

branches, which are applied to the sarcous elements. In the Frog the fine nerves, with their investing sheaths, come into contact with the sarcolemma and unite with it, so that the nerve, destitute of medullary sheath, breaks up into moderately broad fibres, which branch and rebranch, and enter to a slight depth into the muscular fibril. Usually the branching fibres are dilated here and there, and marked with granular swellings, resembling and intermediate in size between the muscle-nuclei and those of the sheath of Schwann. A fine tortuous fibre comes from the broad nerve-fibre, which is itself an axis-cylinder (see NERVES), and runs into the small granular mass and terminates in its pointed end in a small swelling. In *Lacerta viridis* (fig. 503), the

Fig. 503.



Muscular fibres with nerve-ends from *Lacerta viridis*. A. Seen in profile : *P P*, the terminal nerve expansion or plate ; *S S*, its support or base, consisting of a granular mass with nuclei. B. The same, seen in a perfectly fresh muscular fibre.

ultimate nerve-fibril forms a conical elevation on the muscular fibril, and the axis-cylinder passes through the conjoined nerve- and muscle-sheaths to form an expansion on the sarcous elements, but separated from them by a layer of nuclei and granular protoplasm. The expansion may be membranous or fibrillar. These are the appearances in warm-blooded vertebrata also.

Muscle undergoes important changes in disease. Wounds are filled up with areolar or tendinous tissue. In atrophy and fatty degeneration, the bundles become smaller, softer, more readily broken up, the transverse striæ and fibrillæ indistinct, or apparently absent, and contain yellowish or brown pigment-granules, with more or less numerous globules of fat (Pl. 30. fig. 14 *a*) and sometimes a large number of nuclei or small cells.

The interfascicular areolar tissue is also sometimes increased in amount, and fatty tissue developed in it. Sometimes the muscular substance is partially absorbed, and the sarcolemma contracting gives the bundles a moniliform appearance (Pl. 30. fig. 14*b*). In tetanus, the fibres become varicose and often ruptured, and the striæ closer.

The muscular tissue of the lower Vertebrata and some of the Invertebrata agrees essentially in structure with that of man; but the sarcolemma is often much thicker, the fibrillæ larger, and the nuclei contained within the substance of the bundles, and sometimes arranged in regular linear series. The margins of the bundles are also sometimes uneven, and rounded at regular intervals (Pl. 17. fig. 35), giving the appearance of their being surrounded by fibres.

In many of the lower members of the Invertebrata, although the substance of the body is voluntarily contractile, no trace of bundles or fibres can be detected.

These so-called muscle-corpuscles are placed in the interior of the fibre in the muscles of the heart; and they are to be met with in Amphibia, Fishes, and Birds in the same position.

To obtain the separate fibrillæ of striated muscle, the tissue should be macerated for about two hours in alcohol. This removes any fatty matter, and renders the fibrillæ more easily separable by dissection with mounted needles. The fibrillæ are very minute, as we have stated; hence a very small portion of the tissue only should be taken for examination. That of fishes (the cod or the skate), or of reptiles (the frog), is the best for the purpose.

The unstriated muscular fibres are best seen in muscle which has been treated with dilute nitric or muriatic acid (1 part acid to 4 water). This renders them more opaque, and often curiously tortuous or spiral (fig. 502).

BIBL. Bowman, *Todd's Cycl.* iii. art. *Muscle*, and *Phil. Trans.* 1840–41; Lebert, *Ann. des Sc. Nat.* 3 sér. xiii.; Krause, *Arch. f. Anat. u. Phys.* h. v. 646, 1868; Moxon, *Qu. Mic. Jn.* 1866, p. 235; Beale, *Proc. Roy. Soc.* 1863, *Croonian Lect.* 1865; Doyère, *Mém. s. l. Tardigrades, Ann. d. Sci. Nat.* sér. 2, 1840; Kuhne, Brücke, Arnold, & Stricker, *in Stricker's Hum. & Comp. Hist.*

vol. i. 1870; Quain's *Anat.* 1867; Busk & Huxley, *in Kölliker's Hum. Hist.* 1853; Brücke, *Unters. ü. d. Bau, d. Muskel, &c. Wiener Denkschr.* xv. p. 79; Heppner, *Schultz's Archiv,* v. 1869; Schäfer, *Phil. Trans.* v. 163, pt. i. p. 429, 1874; Beale, *How to Work,* 4th edit. p. 333.

MUSHROOMS. See AGARICUS.

MUSSEL.—The species of Mollusca commonly known as mussels are of interest to the microscopist, on account of their alimentary canal containing Diatomaceæ; the same probably applies also to other marine and aquatic Mollusca, as well as other animals living upon these minute Algæ.

If it be required to obtain the valves only, the entire animal may be dissolved in hot nitric acid, and the residue washed as usual in preparing the Diatomaceæ.

The gills of the common marine mussel (*Mytilus edulis*) are well adapted for the examination of the cilia and ciliary motion.

Mussels also frequently contain the 'nurses' and larvæ (*Cercariæ*) of *Distoma* and other Trematoda (Entozoa).

One of the Acarina, *Hydrachna* (?) *concharum* (or *Limnochares* (?) *anodontæ*), is found in the pallial cavity or beneath the outer lamella of the branchial plates of the Naiadeæ (*Unio,* &c.).

BIBL. Dickie, *Ann. Nat. Hist.* 1848, i. p. 322; Vogt, *Ann. des Sc. Nat.* 3 sér. xii.

MUSTARD.—The best mustard consists of the ground seeds of *Sinapis nigra* (Cruciferæ); but those of *S. alba* are largely employed. The structure of these grains is very different from those of the substances most commonly employed for adulteration,—for example, wheat-flour, which is known by its starch-granules. Inferior samples contain variable quantities of the husk of the seed, which may be detected by the microscope. Mustard is generally coloured artificially, especially when adulterated with white meals, by means of TURMERIC, the peculiar colour-cells of which are readily recognizable.

BIBL. Hassall, *Food and its Adulteration,* p. 123.

MYCE'LIUM.—The vegetative part of the Fungi as distinguished from the fruit. It has received different names in different divisions of Fungi, as Hyphasma, Subiculum, Stroma, &c. Many fungi in a barren state have been described as genera, as, for example, *Himantia, Ozonium, Xylostroma.* Mushroom-spawn is simply the mycelioid state of *Agaricus campestris.* The mycelium sometimes penetrates deeply into wood, rendering it of various colours, as green by *Peziza æruginosa,* red by *Corticium sanguineum,* yellow by *Hypoxylon luteum.*

BIBL. Berk. *Outl.* p. 39; *Int. Crypt. Bot.* p. 262.

MYCETOZO'A. See MYXOMYCETES.

MYCOPHY'CEÆ.—The name applied by Kützing and some other authors to a collection of obscure vegetable productions, resembling the mycelia of Fungi, but having the habit of Algæ. It includes the *Cryptococceæ, Leptomiteæ, Saprolegnieæ,* and *Phæonemeæ* of Kützing.

BIBL. Kütz. *Sp. Alg.* p. 145; *Phyc. Gener.* p. 146.

MYCOP'ORUM, Flot.—A genus of Lichenacei.

Char. Thallus thin or obsolete; apothecia black, rotundato-"difformed" or linear, containing many hymenia conjoined as in a common excipulum; hymenia covered with a black rimulo-dehiscent peridium; paraphyses indistinct; spores 8, oblong, variously septate, septa irregular.

2 British species.

BIBL. Leighton, *Lich. Flora.*

MYELIN DROPS.—Spherical and short, cylindrical curved masses, which separate from the medullary investment of a nerve-fibril, or from the whole soft fibre, during and after breaking up by needles in water.

BIBL. M. Schultze, *in Stricker, Hum. & Comp. Hist.* i. 151 (*Syd. Soc.*).

MYELOPLAX'ES.—Large masses of protoplasm with wavy nuclei, that are abundant in the outer layers of the marrow which occupies cavities in bone.

BIBL. Robin, *Jour. d'Anat. et de Phys.* 1864, p. 88.

MYLI'TTA, Fr.—A genus apparently of Tuberacei (Gasteromycetous Fungi).

Mylitta australis, the native bread of the inhabitants of Australia, has not been found with perfect fruit; but the structure is apparently that of Tuberacei. The other species are very doubtful, and perhaps mere root tubercles.

BIBL. Cd. *Ic.*; Berk. *Ann. of Nat. Hist.* 1839, p. 326. t. vii. f. 2.

MYO'MATA and MYXO'MATA. See TUMORS.

MYOSI'TIS TYPHO'SA.—The deposition of typhous cells in the muscular structures, especially in those of the thigh-adductors, and the resulting destruction of the fibres or their replacement by waxy fat, and then by the growth of new ones.

BIBL. Zenker, *Die Veränd. d. willkürl. Musk. im Typh. abd.* Leipsic, 1864.

MYRIAN'GIUM, Berk. and Mont.—A genus of Collemaceæ (Lichens), forming small orbiculate patches radiately plicate round the edge, with shield-shaped apothecia of the same colour, growing on the branches of trees. *M. Duriæi* has been found in the Channel Islands.

BIBL. Berk. and Mont. *Ann. des Sc. Nat.* 3 sér. xi. p. 245; *Lond. Jn. of Bot.* 1845, p. 72; Leighton, *Lich. Fl.* p. 37.

MYRIAP'ODA.—An order of Insects.

Char. Wings absent; legs numerous; thorax not separated from the abdomen.

These animals are commonly known as centipedes or millipedes.

The body is usually long, cylindrical or flattened, and consisting of numerous rings or joints. The head distinct, and the jointed legs arranged on each side of the body throughout its length. A few of them are broad, short, and flattened, somewhat resembling wood-lice. The head is furnished with a pair of antennæ. Behind these are laterally placed the eyes, which in some are absent; they consist of mostly a group of ocelli.

The structure of the trophi varies in the different genera. The labrum is small, and usually consolidated with the cephalic plate. The mandibles (Pl. 28. figs. 25, 26 *b*) are often large and powerful, somewhat resembling those of the spiders, and, like them, traversed by a canal, through which the duct of a poison-gland passes. The maxillæ are smaller, softer, and furnished with two palpi. The labium (Pl. 28. fig. 26 *a*) is often deeply cleft, its anterior and inner margin elegantly toothed; and to it are attached the labial palpi (fig. 26 *c*). In some the labial palpi and mandibles are absent, the labium forming a kind of sheath or suctorial rostrum.

One or two pairs of legs, with a single claw, are attached to each joint of the body.

The internal structure resembles that of other insects.

The sexes are separate. The embryo, on escaping from the ovum, has but few legs, sometimes three pairs, at others none, the number being augmented each time the skin is cast; the same applies to the ocelli.

The Myriapoda live in dark places, beneath the bark of trees, under dead leaves, stones, &c.

They form very interesting objects when properly prepared and mounted. The small ones, when slightly compressed between two glasses, dried in that position, subsequently macerated in oil of turpentine, and mounted in balsam, become very transparent, and show the structure beautifully; the nervous ganglia and cords are often very distinctly seen in these specimens without dissection. The abdomen of the longer specimens should be slit up with fine scissors, and the viscera removed—the integument being gently compressed, and dried as above.

BIBL. Newport, *Linn. Trans.* xix.; id. *Phil. Trans.* 1841; Gervais, *Ann. des Sc. Nat.* 2 sér. vii.; Leach, *Linn. Trans.* xi.; R. Jones, *Todd's Cycl. Anat. and Phys.* iii.; Fabre, *Ann. des Sc. Nat.* 1855. iii.; A. Packard, jun., *Amer. Naturalist,* iv.; Cope, *Trans. Amer. Ent. Soc.* 1870; Lubbock, *Linn. Trans.* 1867.

MYRIONE'MA, Grev.—A genus of Myrionemaceæ (Fucoid Algæ), consisting of minute epiphytic plants, forming patches of short, erect, simple, jointed filaments, springing from a thin expanded layer of decumbent cohering filaments. They are described as bearing oblong 'spores;' but these are probably *sporanges* producing zoospores; and it is probable that they are accompanied by septate sporanges, as in *Elachistea.*

BIBL. Harvey, *Brit. Mar. Alg.* p. 51, pl. 10 E; Grev. *Sc. Crypt. Flor.* pl. 300; Harv. *Phyc. Brit.* pl. 41 A; Hook. *Brit. Fl.* ii. pt. 1. p. 391.

MYRIONEMA'CEÆ.—A family of Fucoideæ. Olive-coloured sea-weeds, with a tuber-shaped or crustaceous spreading frond, sometimes minute and parasitical. Ovoid unilocular, and filamentous multilocular sporanges attached to the superficial filaments, and concealed among them.

MYRIOTHE'LA, Sars.—A genus of Myriothelidæ (Hydroida). Syn. *Candelabrum,* De Blain.

Char. Polypites solitary, cylindrical, terminating above in a conical proboscis, springing from an adherent base, which is clothed with a chitinous polypary; tentacles very small, capitate, covering the greater portion of the body; gonophores on coryniform processes clustering round the base of the polypites, and containing fixed sporosacs.

1 British species.

BIBL. Sars, *Zool. Reise, in Lofoten,* &c.; Gosse, *Marine Zool.* p. 19. fig. 25; Hincks, *Brit. Hyd. Zooph.*

MYRIOTRICH'IA, Harv.—A genus of

Ectocarpaceæ (Fucoid Algæ), consisting of minute epiphytic plants, forming tufts of capillary filaments on larger Algæ. The filaments are simple jointed tubes, set all over with minute, simple, spore-like ramules, which again are clothed with very slender, long, articulated filaments. The fructification consists of oval unilocular *sporanges* on the sides of the main axis, producing zoospores; probably also multilocular sporanges exist.

Bibl. Harv. *Phyc. Brit.*; *Brit. Mar. Alg.* p. 63, pl. 9 D; *Hook. Journ. Bot.* i. p. 300, t. 138.

MYROTHE'CIUM, Tode.—A genus of Stilbacei (Hyphomycetous Fungi).

M. roridum, Tode, occurs on decayed plants, fungi, &c. It has no peridium, but consists of minute subcylindrical spores seated on a thin base, the whole forming a subgelatinous mass, which is exactly analogous to the fructifying mass of Phalloidei.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 323; Fries, *Summa Veg.* p. 448; Cooke, *Handb.* p. 559.

MYXAS'TRUM, Haeckel.—A genus of Monera.

Char. A simple shapeless protoplasm body without vacuoles, which protrudes simple or ramifying and anastomosing processes. Reproduction by radial fission. The encapsuled resting body divides into a great number of germs, whose longitudinal axis is radially directed towards the centre of the globular cyst. Each separate germ surrounds itself with a siliceous covering. The germs issuing from these spore-coverings at once assume the form of the full-grown organism.

Species 1: *M. radians.* Lanzerote, Canaries.

Bibl. Haeckel, *Monog. of Monera, transl. in Qu. Mic. Jn.* ix. n. s. p. 342.

MYXODIC'TYUM, Haeckel.—A genus of Monera.

Char. Several simple shapeless protoplasm bodies without vacuoles; pseudopodia ramifying, anastomosing, and linking the mass into a net. Reproduction probably by division, each individual producing new colonies.

Species 1: *M. sociale.* Bay of Algesiras.

Bibl. Haeckel, *Monog. of Monera, Qu. Mic. Jn.* vol. ix. n. s. 339.

MYXOGAS'TRES.—A family of minute Gasteromycetous Fungi, of curious and interesting structure, characterized by their development from a mucilaginous filamentous matrix, out of which arise sac-like dehiscent peridia, emitting a very remarkable, often reticulated, filamentous structure, bearing the spores.

The Myxogastres grow upon bark of trees, or decayed wood, or on leaves (especially under certain atmospheric conditions), or on the ground; and their evanescent mycelium consists of diffluent mucilaginous filaments of varied form and colour. In proportion as these acquire consistence, there is formed a crust common to the whole mass, divided within into chambers, or a number of individuals appear separate from it and associated on a common thallus. In the first case a single peridium is formed, which may be regarded as a common peridium if we consider the inner cells as partial peridia soldered together, while in the second case each individual has its own peridium. This peridium, sessile or stalked, is composed of one or more membranous, papery, or crustaceous coats; in some cases where there are two coats, the outer is crustaceous and persistent, or it is extremely thin and membranous, and breaks up into deciduous scales. The mode of dehiscence varies. Sometimes an irregular opening is formed at the summit, as in *Physarum*; sometimes the peridium opens like a little box, as in *Craterium* (fig. 145, p. 203); sometimes the upper half falls off, leaving a cup-shaped base, as in *Arcyria*; or the membrane may be very delicate, and break up entirely into little scales, which fall off and leave the *capillitium* with its spores naked, as in *Stemonitis.* The *capillitium* or sporiferous structure is formed of filaments, simple or branched, free and loose, or anastomosing so as to form a network (fig. 147, p. 204); in *Trichia* these have spiral markings, and resemble the elaters of Hepaticæ (Pl. 32. fig. 39). The filaments are often elastic, and when the peridium bursts they rise from the bottom of it, forming a coloured, erect or drooping plume (*Arcyria*). In many species there is a stalk (*columella* or *stylidium*) in the centre of the capillitium. The spores appear to be produced upon these filaments by growing out from them in the manner of basidiospores. They are formed in vast numbers, and lie, when complete, on the branches and in the interstices of the capillitium.

De Bary asserts that the mucilaginous filaments of which the mycelium is formed, exhibit a creeping movement and a changeable form, like what is observed in the Amœbæa, and that the foundation of the

peridia is laid by a quantity of the filaments crowding together into a common mass.

The spores also produce in germination bodies which cannot be distinguished from Amœba, though according to Corda they sometimes give rise to threads as in other Fungi. De Bary considers them animal organisms; but this opinion seems to rest on partial views. In *Badhamia,* which is separated from *Physarum,* the spores are at first contained in a distinct sac; and this appears to be also the case in some Reticulariæ.

Bibl. Schmitz, *Mycologische Beobachtungen*; *Linnæa*, xvi. 188; De Bary, *Botanische Zeitung*, 1858, p. 357; and in Hoffmeister, *Handb. d. Phys. Bot.* ii. 295.

MYXOMYCE'TES. — The mycelium threads and spores of the Myxogastres exhibit pseudopodial movement, and resemble many of the protozoa in the streaming circulation of the granular protoplasm. The movements resemble those of *Amœba* and *Gromia*; and the particles fuse together, forming a plasmodium. Kühne states that the protoplasm of this fungus is formed of a mixture of different albuminoid matters, among which are found myosin, lecythin, and a substance very similar to vegetable cellulose. The spores of *Æthalium*, according to De Bary, rupture their cell-wall, and the contents escape and become furnished with one or two cilia and two or three vacuoles, one of which pulsates. The cilia are lost after a few days; and the mass enlarges and becomes amœboid, and contains several vacuoles. Then an enormous extension of contractile protoplasmic threads takes place; and these give origin to the fructification. The protoplasm catches up Algæ and sporules of fungi in its interior. De Bary considered that in this form the Myxogastric plant was animal; but the phenomena simply prove that it is impossible to draw a hard and fast line between the simplest animals and plants.

See Myxogastres.

MYXOR'MIA, Berk. and Br.—A genus of Coniomycetes, containing one species, *M. atroviridis*, forming minute cup-like bodies, on dead leaves of grass. It is allied to *Excipula*, but differs in its concatenate spores being connected by a slender thread, which frequently breaks off with them; spores very gelatinous.

Bibl. Berk. and Br. *Ann. Nat. Hist.* 2 ser. v. p. 457, pl. 2. fig. 9; Cooke, *Handb.* 459.

MYXOT'RICHUM, Kze.—A genus of Dematiei (Hyphomycetous Fungi), growing on rotten wood, paper, &c. Three species are described as British: *M. cæsium*, Fr.; *M. chartarum*, Kze.; and *M. deflexum*, Berk. They form little tufts or downy balls, sending off radiating branched filaments. The spores are described as occurring collected in masses about the base of the threads.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 335; *Ann. Nat. Hist.* i. p. 260, pl. 8. fig. 9; Fries, *Summa Veg.* p. 502; *Syst. Myc.* iii. p. 348; Church, *Ann. N. H.* 1862.

MYZOCY'TIUM, Schenk.—A genus of Saprolegnieæ (Algæ). Allied to *Achlya*, *Achlyogeton*, and *Pythium*.

Bibl. Rabenh. *Fl. Alg. Eur.* iii. p. 277.

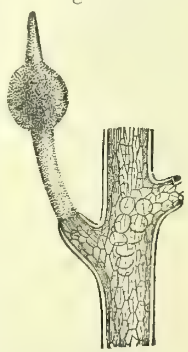
MYZOS'TOMA.—A genus of Annelida parasitic on Comatulæ.

Bibl. Mecznikow, *Zeit. f. wiss. Zool.* xvi.; *Ann. Nat. Hist.* v. 18, 1866, p. 40.

N.

NACCA'RIA, Endl.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one rare British species, *N. Wigghii*, usually thrown up from deep water. Its rose-coloured frond is 6 to 12″ high, and consists of a branched filiform expansion, the central axis being about as thick as a crow-quill, the branchlets quadrifariously alternate and clothed with ramules about 1-12″ long. The cells of the main axis and branches of the frond are large and empty in the centre, small and closely packed at the circumference; the ramules are composed of jointed dichotomous filaments having a whorled arrangement, surrounded by gelatinous matter. The difference between the character of the axes and the ramules is shown in the figure (fig. 504). The spores are borne on branches of the filaments of the ramules, the fertile ramules being swollen in the middle.

Fig. 504.



Naccaria Wigghii.
Fragment of a branch with a fertile ramule.
Magnified 10 diameters.

Bibl. Harvey, *Brit. Mar. Alg.* p. 152, pl. 20 D; *Phyc. Brit.* pl. 38; Greville, *Alg. Brit.* pl. 16.

NAÏDI'NA.—A family of Annulata, of the order Oligochæta.

Char. Body worm-like, annulate or segmented, without suckers or soft leg-like appendages; segments furnished with partially retractile bristles or setæ, excepting the first three or four; head distinct from the body.

Animals aquatic, living among aquatic plants, or burrowing in mud. Sexes distinct; propagation by ova and by spontaneous transverse division. The bristles are moved by muscles, and answer the purpose of legs. They are situated on the upper or under surface of the body, mostly in rows.

The Naïdina are remarkable on account of the singular process of non-sexual multiplication which they present before they attain sexual maturity. A bud is thrown out between two rings near the middle of the body, and it is developed into a fresh individual; moreover the parent body separates at this point, and becomes two individuals. Prior to the detachment of the bud others are formed from the same segment. For the anatomy of the group, see TUBIFEX.

Nais, Müll. Four anterior segments without upper bristles.

Chætogaster, Baer. All the segments without upper bristles.

See TUBIFEX.

BIBL. Schmidt, *Müller's Archiv*, 1846, p. 406; Dugès, *Ann. des Sc. Nat.* 2 sér. xv. p. 319; Doyère, *Mém. Linn. Soc. of Normandy*, x.; Claparède, *Rech.* Geneva, 1861.

NAILS.—These organs, which consist of modified epidermic formations, are imbedded posteriorly and laterally in depressions, or are covered at these parts by a fold of the skin. The posterior depression (fig. 505 *d*) is much deeper than the lateral depressions (fig. 506 *c*).

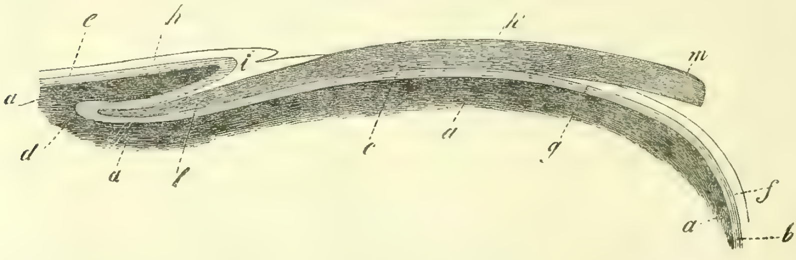
The nail itself consists of the root (fig. 505 *l*), the body (*k*), and the free end (*m*). The root extends over that part of the matrix furnished with the ridges, and is either entirely lodged in the posterior depression of the cutis, or the crescentic portion of it is exposed. The body of the nail is uncovered except at the sides, which are overlapped by the lateral folds of the skin.

The portion of the cutis (fig. 506 *a*) to which the under surface of the nail, except that of the anterior free portion, is attached —the matrix or bed—is covered with ridges (fig. 506 *a*) extending from the posterior part or root of the nail to the convex margin of the white crescentic portion called the lunule, where they become larger and higher, forming plates which run to the end of the matrix. The margins of the ridges and plates are covered with short papillæ. The anterior portion of the matrix of the nail is very vascular.

The under surface of the root and body of the nail is covered with depressions and ridges to adapt itself to those of the matrix.

Two layers are distinguishable in the nails—an under soft layer (figs. 505 *d*, 506 *c*, 507 *B*), corresponding to and directly continuous with the rete mucosum of the skin,

Fig. 505.



Longitudinal section through the middle of the nail and its matrix. *a*, matrix and cutis of the back and point of the finger; *b*, rete mucosum of the point of the finger; *c*, that of the nail; *d*, that of the bottom of the root-fold; *e*, the same of the back of the finger; *f*, epidermis of the point of the finger; *g*, its origin beneath the margin of the nail; *h*, epidermis of the back of the finger; *i*, its termination at the upper surface of the root of the nail; *k* body, *l* root, *m* free end of the proper nail.

Magnified 8 diameters.

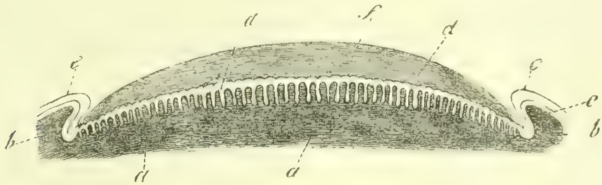
and the upper horny layer forming the true nail (figs. 506 *f*, 505 *k*, 507 *C*). The lower surface of the latter is furnished with small ridges (fig. 507 *c*), which occupy corresponding furrows in the mucous layer.

In minute structure the soft layer resem-

bles that of the cutaneous rete, except in the deeper layers of cells being elongated and arranged perpendicularly (fig. 507 *b*).

The horny portion, or proper nail, consists of epidermic cells, flattened and aggregated into plates or laminæ (fig. 507 *C*). In

Fig. 506.

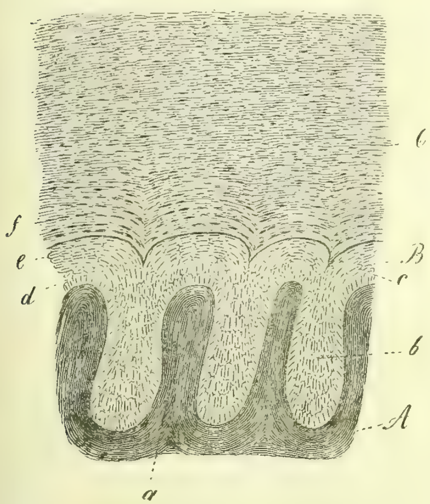


Transverse section of the nail and its matrix. *a*, matrix with its ridges (black); *b*, cutis of the lateral fold; *c*, rete mucosum of the same; *d*, rete mucosum of the nail with its ridges (white); *e*, epidermic layer of cutaneous fold; *f*, proper substance of the nail, with short teeth on its under surface.

Magnified 8 diameters.

the natural state, these cells are undistinguishable, except at the root and the under surface, where the nail is in contact with the mucous layer—the remainder merely exhibiting shorter or longer dark lines, re-

Fig. 507.



Transverse section of the body of the nail. *A*, cutis of the matrix. *B*, rete mucosum of the nail. *C*, epidermis of the same, or proper nail. *a*, plates of the matrix; *b*, plates of the rete mucosum of the nail; *c*, ridges of the proper substance of the nail; *d*, deeper perpendicular cells of the rete mucosum of the nail; *e*, upper flattened cells of the same; *f*, nuclei of the cells of the proper nail.

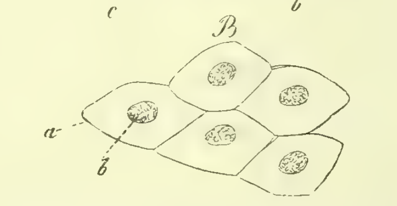
Magnified 250 diameters.

presenting the flattened nuclei, or indicating the existence of the laminæ. But if a section of nail be treated with solution of caustic potash or soda, the nucleated cells swell up, and resume their proper form and appearance.

The blood-vessels of the bed of the nail form a coarse plexus in the corium of the matrix, from which loops are given off to the papillæ; and the proper bed of the nail has a much finer plexus and loops ascending to the ridges.

Numerous medullated nerve-fibres lie in

Fig. 508.



Laminæ of a nail after boiling with solution of caustic soda or potash. *A*, side view. *B*, surface view. *a*, cell-membranes; *b*, nuclei seen from above; *c*, the same in side view.

Magnified 350 diameters.

the subcutaneous tissue of the nail-bed and lose their medullary sheath at the level of the corium, and then run vertically to the surface.

The cutaneous epidermis (fig. 506 *e*) extends for a certain distance into the lateral and posterior depressions of the skin, covers the anterior portion of the root, the posterior part of the body, and the lateral margins of the nails, terminating in a fine layer, which, however, is nowhere directly continuous with the substance of the nail.

BIBL. Kölliker, *Mik. Anat.* ii. and the *Bibl.* therein; Biesiadecki, in *Stricker's Man. Hum. & Comp. Hist.* (*Syd. Soc.*).

NAIS, Müll. See NAÏDINA.

NAR'COTINE. See ALKALOIDS, p. 30.

NAS'SULA, Ehr.—A genus of Infusoria, of the family Trachelina.

Char. Body covered with cilia arranged in longitudinal rows; mouth surrounded by a cone of rod-like teeth; no proboscis nor ear-like processes.

The gastric sacculi of these animals frequently contain a violet-coloured liquid, derived from the solution of partly digested *Oscillatoriæ.*

N. elegans (Pl. 24. fig. 45; *b*, teeth). Length 1-144 to 1-120''.

N. aurea (Pl. 24. fig. 46). Length 1-120''.

It is questionable how far this genus is different from *Chilodon.*

BIBL. Ehr. *Infus.* p. 338; Stein, *Infus.* p. 248; Cohn, *Qu. Mic. Jn.* 1859; Clap. et Lach. *Etudes.*

NAU'PLIUS.—A larval form of some Crustacea which undergo metamorphosis. The name was given by O. F. Müller to the unsegmented crustacean larvæ with a median frontal eye and three pairs of swimming-feet, but without a true carapace. In the prawn these microscopic larvæ have no masticating organs even. This rudimentary larva moults shortly, and a fold of skin grows across the back behind the third pair of feet, and four pairs of stout processes (rudiments of new limbs) sprout forth on the ventral surface; within the third pair of feet mandibles are developed. In a subsequent moult the new limbs come into action, and the Nauplius becomes a Zoëa.

BIBL. Fritz Müller (tr. by Dallas), *Facts for Darwin.*

NAVICELLÆ, PSEUDO- or PSOROSPERMS.—The parasitic Protozoa, the Gregarinida, undergo an encysting process, and their body becomes spherical, motionless, and covered with a structureless tissue. The nucleus disappears, and the sarcode of the animal breaks up into a number of globular particles, which gradually become fusiform and boat-shaped. The cyst bursts and the Navicellæ are set free; they then assume an amœboid condition, and eventually develop into the parent form. They resemble the Naviculæ in shape; but they have no silex around them.

BIBL. Lieberkühn, *Mém. de l'Acad. Roy. de Belg.* xvi.; Van Beneden, *Qu. Mic. Journ.* 1870, p. 51; E. Ray Lankester, *Qu. Mic. Journ.* 1870, p. 58.

NAVIC'ULA, Bory.—A genus of Diatomaceæ.

Char. Frustules single, free; valves oblong, lanceolate or elliptical, sometimes with the ends narrowed and produced, rarely constricted in the middle, furnished with a longitudinal line or keel, and a nodule in the middle and at each end; surface of valves covered with depressions or dots arranged in transverse or slightly radiating rows, producing an appearance of lines, although both dots and lines are often invisible by ordinary illumination.

The valves are usually symmetrical, and the keel median; but in two species the keel is sigmoid and the valves inequilateral. Sometimes the keel is double. There is mostly a little space between the rows of dots (Pl. 11. fig. 8), so that these readily exhibit transverse lines or striæ by unilateral oblique light; but sometimes they are pretty uniformly distributed, as in many of the species belonging to the first section of *Gyrosigma.*

The species or forms are very numerous. Kützing describes 170, some of them, however, belonging to *Pinnularia, Gyrosigma,* and other genera. Rabenhorst notices 237 species. Many may have been derived from a frustule of a *Schizonema* or *Colletonema* which had escaped from its gelatinous envelope!

The formation of sporangial frustules has been noticed by us in *Navicula amphirhynchus,* and they are contained in a siliceous sporangial sheath or case. The process is sufficiently illustrated by the figures (Pl. 41. figs. 19–24): fig. 19, side view of the parent frustule; fig. 20, front view of conjugating frustules, with young sporangial sheath; fig. 21, empty mature sheath; fig. 22, crushed empty sheath and parent frustules *in situ*; fig. 23, sheath, one parent frustule and sporangial frustule in front view; fig. 24, sporangial frustule in side view.

For description of the movement of Naviculæ, see DIATOMACEÆ.

1. *N. cuspidata* (Pl. 11. fig. 6, side view;

fig. 7, front view; *a*, hoop). Valves lanceolate, somewhat rhomboid, acuminate; aquatic; length 1-350 to 1-200″. Valves slightly iridescent, no striæ by ord. illum.

2. *N. didyma* (Pl. 11. fig. 9). Valves elliptic-oblong, slightly constricted in the middle; marine; length 1-600 to 1-300″. Ends sometimes broadly rounded, and the constriction very deep.

3. *N. rhomboides.* Valves rhomboid-lanceolate; colourless and not striated by ordin. illum.; aquatic; length 1-350″. Striæ 85 in 1-1000″ (Sm.).

4. *N. amphirhynchus* (Pl. 41. fig. 19, side view; fig. 22, front view of conjugating frustules). Valves linear, or nearly so, suddenly contracted near the produced and obtuse ends; aquatic; length 1-500 to 1-250″.

Bibl. Smith, *Brit. Diatom.* i. 46; Kütz. *Bacill.* p. 91, and *Sp. Alg.* p. 69; Grev. *Navicula*, n. sp., *Mic. Trans.* 1866, pp. 84 & 126; O'Meara, *Navicula*, pec. forms of, *Qu. Mic. Jn.* 1872, xii. p. 283; Rabenh. *Fl. Eur. Alg.* i. p. 169.

NEBA'LIA, Leach.—A genus of Entomostraca, of the order Phyllopoda, and family Aspidophora.

Char. Antennæ two pairs, large and ramiform; eyes two, stalked; legs twelve pairs, eight branchial and four natatory; carapace large, enclosing head, thorax, and part of abdomen.

N. bipes (Pl. 14. fig. 28). Marine; body yellowish; length 3-8″.

Bibl. Baird, *Brit. Entom.* p. 36; Claus *in Sieb. & Köll. Zeitschr.* 1872, p. 323.

NECKE'RA, Hedwig.—A genus of Hypnoid Mosses.

Elegant little perennial plants, growing on trunks of trees and shady rocks, having stems pinnately branched, bearing complanate leaves arranged in eight rows.

N. crispa, Dill., found in mountainous districts, is a large moss, with stems 4 or 6″ long or more, growing horizontally from a creeping rhizome.

NECTRIA, Fries.—A genus of Sphæriacei (Ascomycetous Fungi), distinguished from true *Sphæriæ* by the free, membranous, flaccid, brightly-coloured perithecium, the pale papilla, and the gelatinous pale nucleus expelled in the form of a drop or of white flocks; the asci contain eight pellucid spores. The imperfect forms of these plants are described as distinct genera. Thus *Tubercularia vulgaris*, common on bark of dying or dead trunks, and on dead twigs of birch especially, ripens into *N. cinnabarina*; this we have observed; and it is probable that other Coniomycetous forms will require to be reduced in like manner. *Nectria* includes the following *Sphæriæ* of the British Flora—*cinnabarina, coccinea, ochracea, aurantia, rosella, citrina, Peziza, sanguinea, episphæria*, &c.; and several new species are described by Messrs. Berkeley and Broome.

Bibl. Fries, *Summa Veg.* p. 387; Berk. & Broome, *Ann. N. Hist.* 2 ser. xiii. p. 467; Cooke's *Handb.* p. 780.

NEMA'LEON, Targioni.—A genus of Cryptonemiaceæ (Florideous Algæ), containing two British species, one, *N. multifidum*, not uncommon on shells and stones near low-water mark. Its frond consists of a somewhat cartilaginous, simple or once or twice dichotomous cord, 3 to 6″ high and 1 to 2‴ in diameter, of a dull purple colour. The cord consists of a dense axis formed of interlaced longitudinal filaments, clothed with horizontal, dichotomously-branched filaments, moniliform and coloured towards the circumference of the cord. The fruit consists of:—1. *favellidia*, consisting of globular masses of "spores" attached singly to the filaments of the periphery (MM. Derbès and Solier say that the single cells arising from the filaments each *discharge* one spore from the interior, so that they are spore-sacs); and 2. collections of *antheridia*, consisting of minute hyaline cells seated on the peripheral filaments, exactly corresponding to the spore-sacs, but discharging spermatozoids.

Bibl. Harv. *Br. Mar. Alg.* p. 153, pl. 21B, *Phyc. Brit.* pl. 36; Derbès and Solier, *Ann. des Sci. Nat.* 3 sér. xiv. p. 274, pl. 35; Thuret, *ibid.* 4 sér. iii. p. 21.

NEMAS'PORA, Fries.—A supposed genus of Melanconiei (Coniomycetous Fungi), the species of which present two forms, one bearing minute conidia (*Nemaspora*), the other spores (*Libertella*, Desmaz.), and which probably also will be found to exhibit an asciferous form. *N. crocea*, Pers. is common on beech-trees, *N. Rosæ* on roses and lilacs. They are at first minute gelatinous masses of conidia, coherent into a nucleus under the epidermis, devoid of a perithecium; the spores finally exude as a gelatinous tendril; the spores are curved and of an orange-colour. *Nemaspora* consists really of spermogonous fruits, and *Libertella* of stylosporous fruits of Ascomycetous genera.

Bibl. Berk. *Brit. Fl.* ii. pt. 2. p. 355;

Fries, *Summa Veg.* p. 413; Desmaz. *Ann. des Sc. Nat.* 1 sér. xix. p. 269, pl. 6. figs. 3–6.

NEMATHE'CIA.—Wart-like collections of vertical filaments found on the surface of the fronds of the Cryptonemiaceæ (FLORIDEÆ).

NEMATOI'DEA.—An order of Scolecida, subkingdom Annuloida. They are familiarly known as "round worms" or "thread-worms," and are elongated and cylindrical in shape. They possess a distinct mouth, and an alimentary canal with an anus. The water-system of contractile canals opens either by lateral pores or near the anterior and under part of the body. The sexes are distinct, and the females abound more than the males. The nervous system is a ganglionic ring round the œsophagus, which sends filaments backwards. The Nematoidea are parasitic and non-parasitic. The first group inhabit the alimentary canal, the lung-tubes, or the areolar tissue of man, and many mammalia; and the second group contains amongst other genera the ANGUILLULÆ, which see. The two groups are united by *Ascaris nigrovenosa*, which in succeeding generations is alternately free and parasitic (Mecznikow and Bastian). This *Ascaris* inhabits the lungs of frogs, and the young become free, passing from the frog into damp earth or mud. Here they grow rapidly and become sexually perfect in a short time. Young, differing somewhat in external characters from the parent form, are produced by them; and these attain merely a certain stage of development whilst in the moist earth, and arrive at sexual maturity only after they have become parasites and are ensconced in the lung of the frog. The parasites are females.

BIBL. Huxley, *Elem. Comp. Anat.*; Carpenter, *The Microscope*; Bastian, *Trans. Linn. Soc.* 1865.

NEMER'TIDA, or Ribbon-worms, belong to the order Turbellaria of the Scolecoid Annuloida. They have a long vermiform shape, a distinct anus and perivisceral cavity; but the water-system has no aperture in the adult. The sexes are distinct, and the pseudo-hæmal system is distinct from the water-system. Reproduction takes place by fission, internal gemmation, and by ova. In Nemertes the egg gives rise to a larva, from which the adult is developed in a manner closely anologous to that of the Echinodermata. See PILIDIUM.

BIBL. Huxley, *Elem. Comp. Anat.*

NEOTTIOS'PORA, Desmaz.—A genus of Sphæronemei (Coniomycetous Fungi), remarkable from the fusiform spores being furnished with three or four terminal threads. *N. Caricum* grows upon dead leaves of sedges, bursting from beneath the epidermis by a circular black orifice, from which an orange-coloured (sometimes olive-coloured) gelatinous mass of spores escapes in the form of a cirrhus. Diameter of conceptacles about 1-80″.

BIBL. Desmazières, *Ann. des Sc. Nat.* 2 sér. xix. p. 346; Berk. & Broome, *Ann. Nat. Hist.* 2 ser. xiii. p. 379.

NEOTTOP'TERIS.—A genus of Asplenieæ (Polypodioid Ferns). The exotic fern called *Asplenium Nidus* belongs here.

NE'PA, Linn.—A genus of Hemipterous insects.

N. cinerea, the common water-scorpion, is of a dirty brown colour, the body broad and flat, with two long terminal respiratory tubes, the anterior pair of legs stout and greatly elbowed, the posterior formed for crawling and not swimming.

Pl. 26. fig. 26 represents the trophi. The labium (*i*) is three-jointed, with two small lobes between the second and third joints; the four setæ (mandibles and maxillæ) are furnished with teeth, directed towards the free end (and not as shown in the figure); the lingua or tongue (*) is trifid at the apex.

The lateral tracheæ are dilated opposite the thorax to form two internal respiratory sacs. The eggs are oval, and with seven reflexed filaments at one end.

BIBL. Westwood, *Introduction*, &c.; Dufour, *Rech. s. l. Hémiptères.*

NEPEN'THES, L.—A genus of Nepenthaceæ (Dicotyledonous Plants), in which the spiral vessels have four parallel fibres (see SPIRAL STRUCTURES).

NEPHROCYT'IUM, Naeg.—A genus of Palmellaceæ (Algæ). Probably decomposing spores of *Spirogyra*.

BIBL. Naeg. *Einzel. Alg.* p. 79.

NEPHRO'MIUM, Nyl.—A genus of Lichenacei.

Char. Thallus membranaceous, fragile, lurid or glaucescent; cortical layer continuous and nerveless. Granular gonima moniliform, dark cæruleo-virescent. Three British species.

BIBL. Leighton, *Brit. Lich. Flora*, p. 104.

NEREID'EA.—An order of Annelida, also called Errantia.

Char. Animal free with setigerous foot-tubercles. Branchiæ in tufts, attached to the sides of the body, in the middle of dor-

sal region only, or along its entire length. The Lob-worm, the sea-mouse, and *Nereis*, the sea centipede, belong to this group.

BIBL. Milne-Edwards *in Todd's Cycl. Anat. & Phys.*; Claparède, *Rech. Anat.* Genève, 1861; Quatrefages, *Etudes Ann. Sc. Nat.* sér. 3. t. x.–xviii.

NERIUM. See STOMATA, and LIBER (p. 450).

NERVES and NERVOUS CENTRES. —The nervous system is usually regarded as consisting of two parts: the nerves, which are divided into the cerebro-spinal and the sympathetic; and the nervous centres, represented by the brain and spinal chord, with which must also be placed the ganglia. These parts are composed essentially either of nerve-tubes, nerve-cells, or of both these elements.

The structural elements are of three kinds, the nerve-fibres, the ganglion cells, and the peripheric terminations of the nerves; and the nerve-fibres may be arranged in two groups, the medullated and the non-medullated.

The medullated nerves are most numerous in the white portion of the nervous centres and in the nerves. They are slender, soft, cylindrical filaments, varying in diameter from 1-20,000 to 1-1100″. When quite recent, they are transparent and apparently homogeneous (fig. 509, 1), but they really consist of three distinct parts—an enveloping membrane or sheath, a tenacious liquid, and a soft but elastic and probably fibrous axis.

The enveloping membrane is termed the tubular membrane; the tenacious substance is the white substance of Schwann or the medullary matter; and the central fibre is the axis-cylinder, or band of Remak.

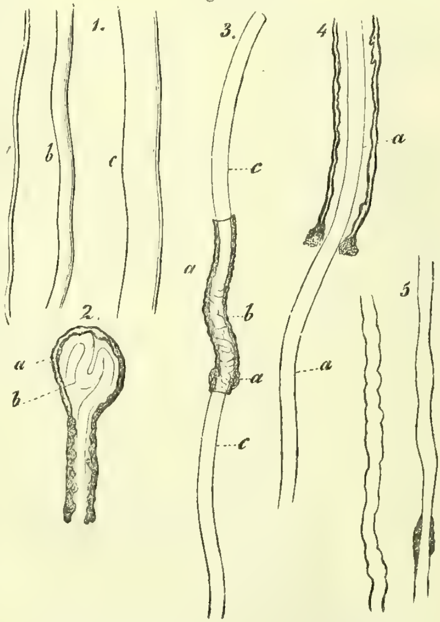
The sheath or tubular membrane of the nerve-tubes is a thin structureless transparent membrane (fig. 510, 1 *a*, 2, 3 *a*, 4 *a*). Nuclei occur in it; and it strengthens the nerve-fibres. It is very visible and thick in the nerves of the mesentery of the frog, and in the electrical organs of the torpedo. Usually termed the "tubular" membrane, it is also called the medullary membrane, or sheath; and the name of Schwann is frequently associated with it; but care must be taken not to confound this external limiting structure with the included medullary substance—the so-called white substance of Schwann.

Within the sheath (figs. 509, 3 *b*, 510, 3 *b*, 4 *b*) is the white substance of Schwann. It is homogeneous and tenacious in perfectly fresh nerves, but soon after death becomes coagulated, sometimes externally only, giving a double outline to the walls of the nerve-tubes (fig. 510, 4, 511), or becoming granular externally, and remaining liquid internally. It is also easily altered by pressure, sometimes escaping in globules or masses of various form, from the ends or the broken sides of the tubes, at others accumulating at intervals in various parts of the tubes, giving them an elegant varicose appearance (fig. 511). See MYELIN.

It is frequently called the medulla of nerves, and those possessing it are "medullated."

The third structure exists within the last, in the form of a rounded or flattened, pale,

Fig. 509.



Nerve-fibres. 1. From nerves of the dog and rabbit, in the natural state: *a*, fine, *b*, moderate, *c*, large fibre. 2. From a frog, after the addition of serum: *a*, drop forced out by pressure; *b*, part of the axial fibre contained in it. 3. From the human spinal marrow, treated with serum: *a*, sheath; *b*, white substance with a double outline; *c*, axial fibre. 4. Fibre with double outline, from the human fourth ventricle: *a*, axial fibre. 5. Two isolated axial fibres, with a portion of the white substance adherent to the right-hand one.

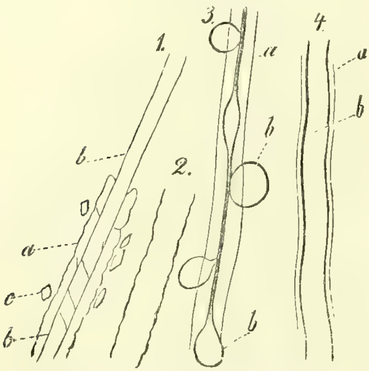
Magnified 350 diameters.

striated band of fibres, occupying the axis of the tube, and called the axis-cylinder (figs. 509, 2 *b*, 3 *c*, 4 *a*, 5; 510, 1 *b*).

These three structures of nerve are somewhat difficult of demonstration. The outer

sheath may sometimes be shown by pressing the nerve-tube, which forces out the white substance. Boiling the nerves in absolute alcohol, with the subsequent addition of caustic alkali, or in acetic acid, when crystals of fat separate from the white substance (fig. 510, 1), will answer the same purpose. Treatment with strong nitric acid, and afterwards with potash, causes the white substance to exude; and the axial fibre being dissolved, the yellow sheath is left empty and very distinct. Solution of corrosive sublimate has also been recommended. The axial band is best seen in nerves treated with strong acetic acid, or cold absolute alcohol, ether, chromic acid, &c., and staining fluids. Perosmic-acid solution hinders the coagulation of the medullary substance, which is oily and very refractive, and turns it black. See PREPARATION.

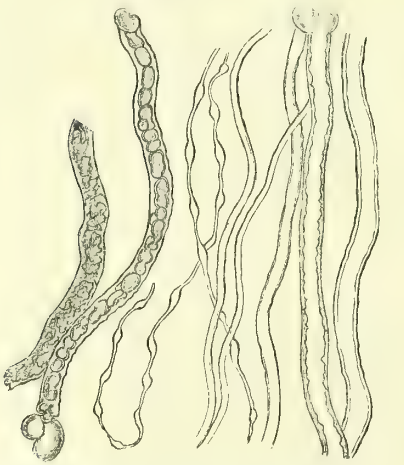
Fig. 510.



Nerve-tubes. 1. From a frog, after boiling with acetic acid and alcohol: *a*, sheath; *b*, axial band; *c*, crystals of fat. 2. Isolated sheath of a frog's nerve boiled with soda. 3. From the human fourth ventricle, after treatment with soda: *a*, sheath; *b*, white substance exuding in drops: the axial band has been removed in the preparation. 4. Human, treated with soda: *a*, sheath; *b*, white substance; the axial band not visible.

Magnified 350 diameters.

Fig. 511.



Human nerve-tubes, showing tubes of various sizes; some with a single, others with a double outline; some varicose, others with the white substance in a granular state.

Magnified 350 diameters.

Chemically the sheath and axial band consist of a proteine compound, and the white substance of a mixture or compound of fat with protagon.

The medullated nerves invariably contain the axis-cylinder and possess the medullary substance of Schwann, but they are not invariably included in a tubular membrane or medullary sheath.

The non-medullated nerves obtain their name from the absence of the white substance of Schwann around the axis-cylinder, and are of three kinds. The primitive nerve-fibrils present the simplest form, and are very fine and thread-like. They are only visible with powers greater than 500 linear, and they may be traced to their junction with ganglion-cells and thicker nerve-fibres. No internal structure can be distinguished in them; and they are subject to become varicose here and there with such reagents as dilute perosmic acid, and finally to become diffluent. They abound in the neighbourhood of the termination of other nerves, for instance, in the retina (see EYE).

The second kind of fibre has been called naked axis-cylinders, and are thicker than the primitive fibrils. They are transparent, and are more or less striated longitudinally, being composed, like the axis-cylinders of medullated nerves, of minute longitudinal fibrils. When connected with multipolar ganglion-cells this fibrillation is often distinct under the action of reagents. They have only been traced for short distances; and it is evident that they and the primitive fibrils may become covered with a "sheath" and merge into the medullated type. The third kind consists of a thicker or thinner bundle of primitive nerve-fibrils, according to the kind of axis-cylinder present, united together by a structureless, perfectly transparent, extremely thin nucleated tissue—the tubular sheath of the medullated fibres.

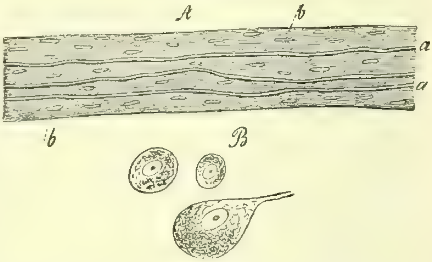
In the cerebro-spinal nerves, the nerve-tubes are aggregated into bundles, and surrounded by an envelope of areolar tissue, called the neurilemma, in which blood-vessels ramify, thus corresponding with the arrangement of the primitive fibrillæ of muscle. Sometimes, towards the terminations of the nerves, the neurilemma appears as a homogeneous membrane with elongated nuclei.

Branching or division of all the nerve fibres, except the non-medullated primitive kind, occurs occasionally in and near the nervous centres and in the nerve-trunks, and frequently in the peripheric extremity. The best example of peripheral division is in the electric eel, where one medullated fibre divides millions of times to supply the subcutaneous fat-like organ. Division into numerous fibres may be seen in sections of the spinal cord of the ox treated with carmine and ammonia.

In the grey, sympathetic, or ganglionic nerves, the fibres of which are sometimes called gelatinous fibres, the nerves are paler than those of most of the cerebro-spinal nerves, and they are both medullated and non-medullated, and some nerve-tubes are of medium size and present dark edges. They are scattered through a more copious areolar sheath or neurilemma of mostly longitudinal fibres (Remak's fibres), containing numerous elongated nuclei (fig. 512).

Nerve-cells, nerve-corpuscles, or ganglion-cells are masses of fibrillar protoplasm, granular and faintly coloured, but without a cell-wall; they have each a nucleus and nucleolus. They are most numerous in the cineritious or dark portions of the nervous centres, and in the ganglia; but they are met with in the trunks and terminal expansions of nerves, as the retina, &c. Some are furnished with a nucleated capsule (fig. 513, 2 *a*); this is easily seen in the

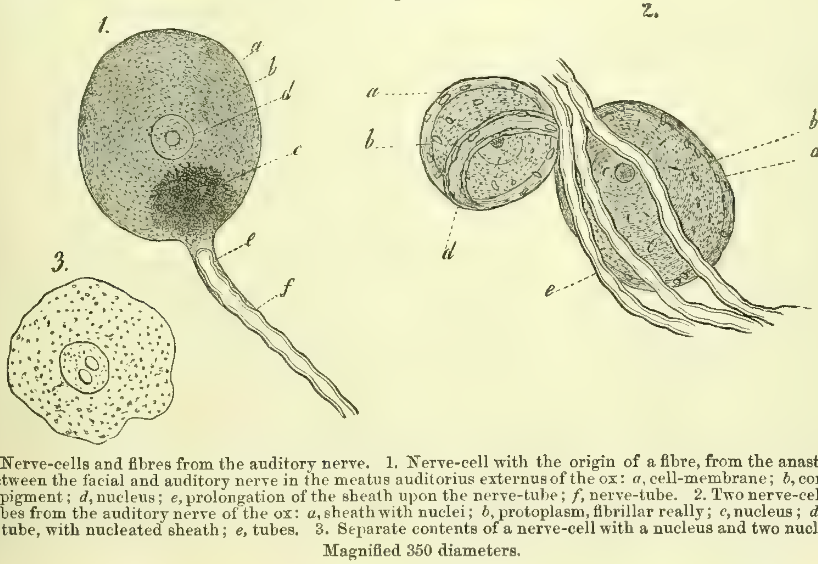
Fig. 512.



From the human sympathetic. *A*. Portion of a grey fibre treated with acetic acid: *a*, fine nerve-tubes; *b*, nuclei of Remak's fibres. *B*. Three ganglion-globules, one with a pale process.

Magnified 350 diameters.

Fig. 513.



Nerve-cells and fibres from the auditory nerve. 1. Nerve-cell with the origin of a fibre, from the anastomosis between the facial and auditory nerve in the meatus auditorius externus of the ox: *a*, cell-membrane; *b*, contents; *c*, pigment; *d*, nucleus; *e*, prolongation of the sheath upon the nerve-tube; *f*, nerve-tube. 2. Two nerve-cells with tubes from the auditory nerve of the ox: *a*, sheath with nuclei; *b*, protoplasm, fibrillar really; *c*, nucleus; *d*, origin of tube, with nucleated sheath; *e*, tubes. 3. Separate contents of a nerve-cell with a nucleus and two nucleoli.

Magnified 350 diameters.

cells of the ganglia, but with difficulty in those of the central organs.

They are rounded, elongate, pyriform, or angular (fig. 513). Some of them are simple, others are furnished with one, two, or more simple or branched processes; hence they are described respectively as uni-, bi-, or multipolar. Their contents are a soft, tenacious, but fibrillar mass (fig. 513, 3), consisting of a clear, homogeneous, proteine basis, and a number of larger and smaller granules, as well as a nucleus and nucleolus. In size they are very variable, from 1-5000 to 1-500″. The granules are sometimes colourless, at others yellow, brown, or black; and occasionally these are aggregated to form a mass.

In the sympathetic, the ganglion-cells have a proper nucleated capsule, and their commonest shapes are the oval, round, and the fusiform, some being almost rectangular. They are of all sizes; and large and small are grouped together.

Most are multipolar; and their processes unite with those of the cells or run into nerves.

The capsule is the analogue of the tubular sheath of the nerves, and consists of nucleated connective tissue. Flattened polygonal cells have been observed on the inner surface of the capsules; and they sometimes exhibit concentric striation with interspersed nuclei.

A number of fine fibres radiating from the nucleus and nucleolus may be seen traversing the cell-substance, which contains granular, yellow or reddish-brown pigment. Chloride of gold renders the nucleus very distinct; and it appears to be traversed by filaments proceeding from the nucleolus. Beale has shown that two processes are given off from the small end of the bell-shaped ganglion-cells of the sympathetic in the frog; and that whilst one pursues a straight course, the other forms a series of coils around it; and both lie within a nucleated sheath, which is continuous with that of the ganglion-cell.

Intermingled with the cells in the cineritious matter of the nervous centres, is a finely granular pale substance resembling that within the cells, also aggregations of free nuclei.

Origin of Nerve-fibres. — The ganglion-cells, whether multipolar or unipolar, are in continuity with nerve-fibres. Some ganglion-cells are merely nucleated dilatations of the axis-cylinder; and others, which are also bipolar, are true ganglion-cells; for the more or less globular cell-mass is continuous with the axis-cylinder and with the granular matter of the medullary matter, but the tubular sheath of the nerve stops short of the cell.

Multipolar ganglion-cells are invariably connected with one medullated nerve-fibre, which passes off without branching or diminishing its calibre. Its axis-cylinder, which is fibrous in texture, is continuous with the fibrillar structure of the protoplasm of the ganglion-cell, and it becomes invested with the medullary sheath soon after leaving the cell. The rest of the processes either communicate with other multipolar cells or break up, after repeated branching, into a great number of processes, which, however, are clearly continuous with the fibrillar protoplasm of the cell, but which are uncovered by any medullary sheath. Their ultimate termination is doubtful; but it is inferred that many of them become continuous with the axis-cylinders of nerves. So fibrillar are the processes (under reagents), and so fibrous is the appearance of the ganglion cell-mass, deficient as it is of cell-wall, that it is imagined that the fibrous structure of the axis-cylinders is continuous with that of each other through the cell-substance. Doubtless many nerve-fibres originate from very small cells, which are imbedded in the grey substance, and which are usually destroyed by the processes of manipulation and preparation.

The *ganglia* consist of nerve-tubes either separate or united into bundles, intermingled with nerve-cells, from which some of the nerve-tubes arise. The tubes and cells are imbedded in or supported by a stroma of areolar tissue, sometimes homogeneous, at others more or less distinctly fibrous, forming an apparent sheath to the ganglia, and ending in numerous septa, rarely but occasionally forming a distinct envelope to the individual cells; sometimes it consists of elongated, triangular, or spindle-shaped nucleated cells — in short, corresponding to areolar tissue in various stages of development.

The general anatomy of the nervous centres is included in all standard anatomical works. The SPINAL CORD will be noticed under that head; and it is therefore only necessary to refer to the histology of certain parts of the brain which are more or less typical. The structure of the convolutions of the outside of the brain, and

the relation of the grey and white elements, differ in several parts of the organ; but the

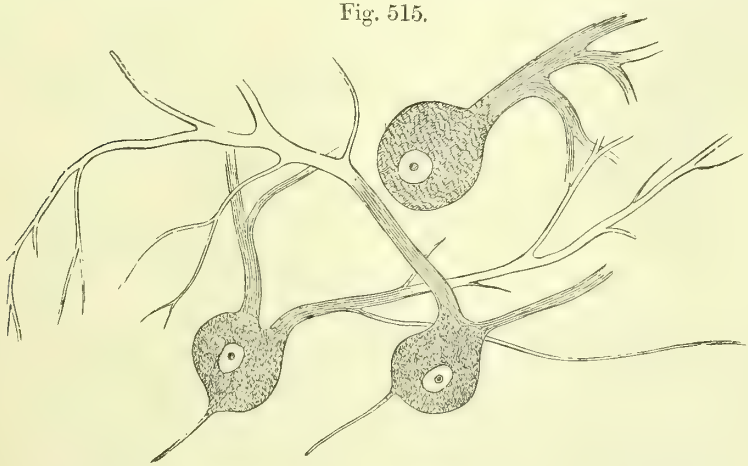
Fig. 514.

Cells from the central grey substance of the human spinal marrow. Some are connective-tissue cells. Magnified 350 diameters.

following description is generally correct. Beneath the investing membrane, the pia mater, is the superficial structure of the brain, which may be divided more or less arbitrarily into five or eight layers. The outer layer is one of unevenly distributed and more or less varicose nerve-tubes of different sizes running horizontally; they are medullated, but are not covered with the tubular sheath. Separated by and resting on a pale layer of sparely nucleated protoplasm, they are even sometimes absent in certain positions; and in others the protoplasmic layer gives place to a densely nucleated protoplasm. These elements, as a whole, constitute the first layer; and ganglionic cells are rare in it. Much of it is non-nervous, and consists of Neuroglia matter, some of which is amorphous and some is organized. The amorphous protoplasm becomes cloudy after death, and it contains organized and minute fibrils and very small dark molecules. Nuclei also, which are pale and pellucid and surrounded with protoplasm in a stellate shape with processes, are probably continuous with the minute fibrils; and the whole is said to belong to connective tissue rather than to nerve. There are, however, true nerve-cells with processes in this outer layer.

The second layer is characterized by close-set, small, pyramidal nerve-corpuscles; and the third layer has larger cells of the same shape, but less closely placed. The cells for the most part, but not universally, are pyramidal; the apex is a long slender process of the protoplasm, which, without

Fig. 515.



Large cells from the grey cortical layer of the human cerebellum. Magnified 350 diameters.

a cell-wall, surrounds a triangular nucleus whose apex sometimes passes into this process, which is often branched at the end. The base has a process which usually passes backwards out of sight, and is not generally admitted to exist; and numerous others come off as lateral basal processes. These well-marked cells are therefore truly fusiform, and have lateral processes. Nerve-tubes are met with in the third layer, passing downwards in fasciculi. The fourth layer consists of small and very closely arranged cells of irregular shape, which give off several very delicate processes; and the nerve-fibres of the last layer pass down through this and the fifth layer to the medullary lamina. The fifth layer has spindle-shaped bodies in it, which are usually placed parallel with the bases of the large cells of the third layer. They have a process in front and behind, and apparently they develop lateral processes which are directed towards the free surface of the brain. They may be nerve-cells; but some anatomists consider them to be connective-tissue corpuscles. The medullary

Fig. 516.

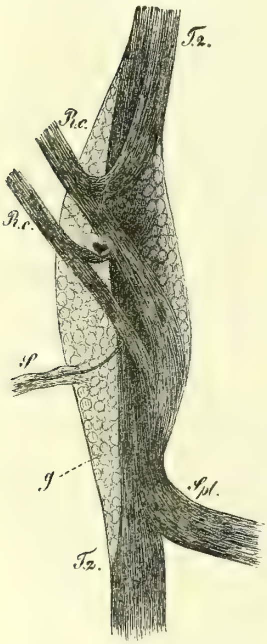


Fig. 517.

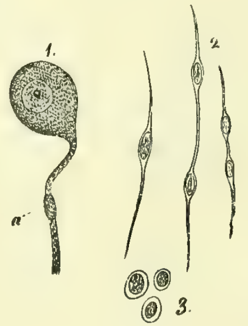


Fig. 518.

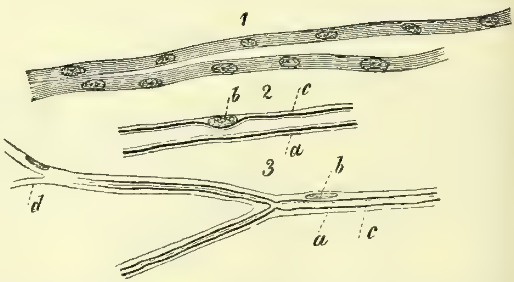


Fig. 516. Sixth thoracic sympathetic ganglion of the left side of a rabbit, seen from behind, after treatment with soda. *T.* 2, trunk of sympathetic; *R.c*, communicating branches, each bifurcating; *Spl.* splanchnic branch *S*, ganglial branch, with large and small branches probably going to vessels; *g*, ganglion-globules and ganglia fibres. Magnified 40 diameters.

Fig. 517. 1. Ganglion-globules from a spinal ganglion of a four-months human fœtus: *a*, nucleus in the pale process of the cell. 2. Nerve-tubes in development, from a two-months human fœtus. 3. Cells from the cineritious cerebral substance of the same fœtus.

Fig. 518. 1. Two nerve-fibres from the ischiatic nerve of a four-mouths fœtus. 2. Nerve-tubes from a newly-born rabbit: *a*, sheath; *b*, nucleus; *c*, white substance. 3. Nerve-fibre from the tail of a tadpole: *a, b, c*, as above; at *d* the fibre has still the embryonic character.

layer, which underlies the fifth layer, commences from fasciculi of fibres, which pass down from the third layer and receive others from the fourth and fifth. The nerves then run at right angles with their former course, and constitute a portion of the superficial white substance of the brain. They are medullated, but have no

tubular sheath. The so-called connective tissue of the first and fifth layers is, as Clelland has shown, very protoplasmic.

In some portions of the brain (for instance, in the cornu ammonis of man) the fourth and fifth layers do not exist, and the second layer has none of the small pyramidal cells; the larger preponderate in the region.

The structure of the olfactory lobe affords another type of structure (see OLFACTORY ORGAN).

The cerebellum, so far as its external structure is concerned, has some histological elements different from those of the brain; but the arrangement is more or less in arbitrary layers. Externally it is united to the pia mater by processes of connective tissue; and beneath these is the pure grey first layer. This external layer contains protoplasmic matter and connective-tissue-looking cells, like the cortex of the brain; and there are also small fusiform nerve-corpuscles, which are in connexion with a layer of transverse and finely varicose nerve-tubes. The second layer contains a large number of the so-called corpuscles of Purkinje arranged in a single layer. These are large cells, with their rounded bases placed away from the surface of the cerebellum, towards which one or more prolongations of the cell pass for some distance, branching according to some microscopists. The cells appear to be invested with a hyaline sheath. The internal layer (third) presents a great similarity to the granule-layers of the olfactory lobes; it consists of a very delicate protoplasm, including crowds of minute naked granules, which branch occasionally like excessively minute multipolar cells. This layer rests on medullated nerve-fibres, in which some of the granules above mentioned are occasionally found.

The nerves are developed from the elementary embryonic cells, which at first appear rounded or slightly elongated and somewhat flattened. In their further growth they either retain the primitive shape (fig. 517), or send out persistent lateral processes, so forming nerve-cells or ganglion-globules; or the processes of adjacent cells unite into nucleated fibres, much resembling those of the sympathetic system, in which the white substance and axial fibre of the nerve-tubes are formed as secondary deposits (fig. 518).

In atrophy and degeneration of the nervous elements, the nerve-cells become loaded with fat and pigment, and the walls of the nerve-tubes thinner, brittle, and the white substance more or less replaced by granules of fat.

Termination of Nerves. See EYE, OLFACTORY ORGAN, MUSCLE, KRAUS'S CORPUSCLES, PACINIAN CORPUSCLES, SALIVARY GLANDS, SKIN.

BIBL. Kölliker, *Mik. Anat.* 2; Todd, *Cycl. Anat. and Phys.* iii.; Paget, *Brit. and For. Med. Rev.* 1842, xiv.; Gerlach, *Mik. Stud.*; Remak, *Monatsb. d. Acad. d. Wiss. zu Berlin*, 1853; Max Schultze, *Obs. de struct. cell. fibr. nerv.* Bonn, 1868; Lister & Turner, *Qu. Mic. Jn.* 1860, p. 29; Mayer, *in Strick. Hum. & Comp. Hist.*; Meynert, *in Strick. op. cit.*; Deiters, *Unters. ü. Gehirn u. Mark d. Mensch.* Brunswick, 1865; L. Clarke, *Phil. Trans.* 1858 & 1868; *Proc. Roy. Soc.* 1863; Stricker, *Qu. Mic. Jn.* x. 71; L. Beale, *Phil. Trans.* 1860, 1862, 1863, 1864, *Croonian Lecture*, 1865; *Archiv of Med.* vol. v.; *Qu. Mic. Jn.* n. s. vols. iv. & v.; *M. Mik. Jn.* 1872; *How to Work*, 4th ed.; Clelland, *Qu. Mic. Jn.* 1870, p. 126; F. Darwin, *Qu. Mic. Jn.* 1874, p. 110; Schmidt, *M. Mic. Jn.* May 1864, p. 200.

NEUROGLIA.—A granular connective tissue, which surrounds the nerve-fibres in the spinal cord and brain, and which contains fine elastic fibres and cells. It is a provision against the various movements to which the nervous centres are exposed.

BIBL. Gerlach, *in Stricker, Man. Hum. & Comp. Hist.* ii. 335.

NEUROP'TERA.—An order of Insects, containing the Dragonflies (LIBELLULIDÆ), &c.

NEW ZEALAND FLAX. See PHORMIUM and TEXTILE SUBSTANCES.

NICOTH'OE, Aud. & Edw.—A genus of Crustacea, of the order Siphonostoma, and family Ergasilidæ.

N. astaci (Pl. 14. fig. 36, fem.) is found upon the gills of the lobster.

The sides of the body are extended into two remarkable lobes, containing the ovaries (*a*) and the intestinal canal.

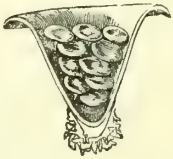
BIBL. Baird, *Brit. Entom.* p. 300; Van Beneden, *Ann. des. Sc. Nat.* 3 sér. xiii.

NIDULARIA'CEI.—A small family of Gasteromycetous Fungi, including the Nidularini or bird's-nest-like Fungi, and the Carpoboli, which contain only one conceptacle. They are curious and very interesting Fungi, growing on the ground among decaying sticks, dung, &c., bearing upon the flocculent mycelium yellow or dull-coloured

fruits or receptacles (fig. 519). The external part of the receptacle consists of a more or less globular or ovate *peridium*,

Fig. 519.

Fig. 520.



Cyathus vernicosus.

Fig. 519. A ripe receptacle. Nat. size.
Fig. 520. The same, opened vertically.

which bursts when mature, in the Carpoboli by a lid or by more or less regular slits, in the Nidularini by an orifice which enlarges so that the mouth becomes turned out as a spreading lip around a cup-shaped cavity (fig. 519). The Carpoboli, containing only one conceptacle, project this out with elasticity when ripe. The Nidularini contain many conceptacles lying like eggs in a nest (figs. 519, 520), in *Cyathus* and *Crucibulum* (fig. 521) attached by a funiculus. The structure of the conceptacles is alike in all. The envelope of each is triple (fig. 522); and they form

Fig. 521.

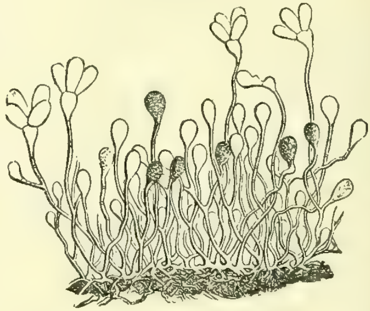
Crucibulum vulgare.
A conceptacle detached from the receptacle.
Magnified 12 diams.

Fig. 522.

Cyathus vernicosus.
A nearly ripe receptacle, cut open vertically, showing the two halves filled with conceptacles.
Magnified 3 diameters.

a cavity lined by delicate filaments which converge towards the centre, where their extremities are expanded into *basidia* crowned by four spores (fig. 523), which are cylindrical and almost sessile. The filaments being of very unequal length, the

Fig. 523.



Cyathus striatus.
Basidia and spores from the fertile layer of a conceptacle.
Magnified 250 diameters.

Fig. 524.

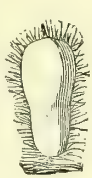
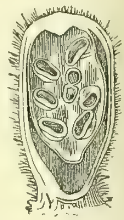


Fig. 525.

Fig. 526.



Cyathus striatus.

Fig. 524. Vertical section of a young receptacle. Magn. 10 diams.
Fig. 525. Another, more advanced. Magn. 10 diams.
Fig. 526. Another, still more advanced. Magn. 5 diams.

basidia are intermingled with them in the cavity of the conceptacle, not forming a definitely marked layer.

Little is known of *Atractobolus*; but there is some reason to believe that it is merely the eggs of an Acarus belonging to the genus *Raphignathus*.

BIBL. Tulasne, L.-R. and C., *Rech. sur les Nidular. Ann. des Sc. Nat.* 3 sér. i. 41; Schmitz, *Mycol. Beobacht. Linnæa*, xvi. 141; Sachs, *Bot. Zeit.* xiii. p. 823.

NIPHOB'OLUS, Kaulf.—A genus of Polypodieæ (Ferns), with elegantly articulated veins and numerous naked sori at the tips of free branchlets.

NITELLA. See CHARACEÆ.

NITOPHYL'LUM, Greville.—A genus of Delesseriaceæ (Florideous Algæ), containing about half-a-dozen British species, only two of which are commonly met with.

Their fronds are membranaceous, of reticulated (parenchymatous) structure, mostly rosy red, without ribs, or with irregular ribs towards the base. The membranously expanded frond of *N. punctatum*, 4 to 12″ high, is either regularly dichotomously divided or parted into two or three principal lobes, which have a border of dichotomous wedge-shaped lobes. *N. lacerum* has the frond 2 to 10″ high, much dichotomously divided and marked with flexuous veins, the segments mostly linear, waved or fringed at the margins. The fructification consists of spores, tetraspores, and antheridia. 1. The spores are contained in *coccidia*, sessile on the fronds, the spores arising from tufted filaments; 2. the *tetraspores* form distinct scattered spots on the frond; 3. the *antheridia* are minute cellules standing perpendicularly on the surface of the frond, collected into patches, only distinguishable by the help of the microscope.

BIBL. Harvey, *Brit. Mar. Alg.* p. 116, pl. 15 B; *Phyc. Brit.* pls. 202, 203, 247, &c.; Greville, *Alg. Brit.* pl. 12; Thuret, *Ann. des Sc. Nat.* 4 sér. iii. p. 22.

NITRATE OF POTASH. See POTASH, Nitrate of.

NITRIC ACID is useful as a reagent (INTROD. p. xl), and for separating the organic matter of the Diatomaceæ from the siliceous valves.

NITZSCH'IA, Denny (*Liotheum*).—A genus of Anoplura.

N. Burmeisteri is the louse of the common swift (*Cypselus apus*).

BIBL. Denny, *Monogr. Anopl.* p. 230.

NITZSCH'IA.—A genus of Annulata.

BIBL. Johnst. *Non-parasitic Worms*, 1855.

NITZSCH'IA, Hass.—A genus of Diatomaceæ.

Char. Frustules free, single, compressed, usually elongate, straight, arched, or sigmoid, with a longitudinal, not median, external keel (?), and one or more longitudinal rows of puncta; suture in front view of frustules not median.

The valves have no nodules; we have not been able to satisfy ourselves of the presence of the external keel; upon the portions of the valves forming the middle of the side view of the frustules are one or two longitudinal rows of slightly elongate dots or puncta (Pl. 13. fig. 10 *d*), often visible under ordinary illumin.; surface of valves covered with smaller dots, mostly opposite (not quincuncial) (fig. 10 *d*), invisible under ordinary illumination.

The frustules and valves are either linear, lanceolate, or of intermediate forms, sometimes constricted or beaked.

1. *N. sigmoidea* (Pl. 13. fig. 9: *a*, side view; *b*, front view); length 1-75″.

2. *N. lanceolata* (Pl. 13. fig. 10: *a*, front view of frustule; *b*, front view of single valve; *c*, side view of frustule); length 1-150″.

Fig. 10 *a* is too broad; the form of the frustules is best represented by 10 *b*; 10 *d* exhibits the two kinds of markings as seen with the stops, &c.

3. *N. longissima* (*N. birostrata*, Sm.) (Pl. 13. fig. 11: *a*, side view; *b*, front view); length 1-70″.

4. *N. acicularis* (Pl. 13. fig. 13 *b*); length 1-300″.

5. *N. reversa* (Pl. 13. fig. 12).

6. *N. tænia* (Pl. 13. fig. 13 *b*); length 1-250″.

BIBL. Smith, *Brit. Diat.* p. 37; Hassall, *Freshwater Algæ*, p. 435; Rabenht. *Fl. Eur. Alg.* i. 149.

NITZSCHIEL'LA, Rabenh.—A genus of Diatomaceæ.

The generic characters resemble those of *Nitzschia*; but the apices are greatly attenuated, elongated, and sometimes twisted.

BIBL. Rabenh. *Fl. Eur. Alg.* i. 163.

NOBERT'S PLATES, or LINES.—M. Nobert, of Greifswald in Prussia, has ruled lines so closely on glass by means of a diamond attached to a very beautiful instrument, that a test for definition and angular aperture has been produced second to none in excellence. What is known as Nobert's Test is a plate of glass, on a small space of which, not exceeding one fiftieth of an inch in breadth, are ruled ten or more series of lines, forming as many separate bands of equal breadth. In each of these bands the lines are ruled at a certain known distance; and the distances are so adjusted in the successive bands as to form a regularly diminishing series, and thus to present a succession of tests of progressively increasing difficulty. The distances of the lines differ on different plates, all the bands in some series being resolvable under a good objective of 1-4th inch focus, whilst the closest bands in others defy the resolving power of a 1-12th inch objective of large aperture. The most recent of these test-plates have nineteen bands, and their lines are ruled at the following distances, expressed in parts of a Paris line, which is to

an English inch as ·088 to 1·000, or as 11 to 125.

Band.		Band.	
1.	1-1000th	11.	1-6000th
2.	1-1500th	12.	1-6500th
3.	1-2000th	13.	1-7000th
4.	1-2500th	14.	1-7500th
5.	1-3000th	15.	1-8000th
6.	1-3500th	16.	1-8500th
7.	1-4000th	17.	1-9000th
8.	1-4500th	18.	1-9500th
9.	1-5000th	19.	1-10000th
10.	1-5500th		

These lines have been resolved by improved object-glasses. The mathematical certainty with which the degree of approximation of these lines may be ascertained, and the regular gradation of the series which they present, gives to M. Nobert's test-plate a very high value for the determination of the relative merits of different objectives, of that class, at least, in which angular aperture and definition are of the first importance.

BIBL. Beale, *How to Work*; Carpenter, *The Microscope*; Woodward, *M. Mic. Jn.* 1871, 118, 1872, 227.

NOCTILU'CA, Suriray.—A genus of Rhizopoda.

N. miliaris is spherical or nearly so, of about the size of a pin's-head, with a tentacle-like, transversely striated, and curved process arising from it, and by means of which it propels itself through the water. Near its attachment is the opening termed the mouth, on one side of which a tooth-like projection is placed. The mouth leads by means of a tubular gullet to an irregular hollow in the sarcode of the interior of the a. imal. This is the stomach, which has a definite anal opening. Around the stomach is a granular homogeneous glutinous substance with indistinct fibrillation. This is the seat of granular movement, and ends in a mesh-like expansion beneath the skin. There is a nucleus; but no vacuoles have been observed. The part to which the curved process is attached is plicate and depressed, so as to render the body somewhat bilobed; it has no carapace. The body is of gelatinous consistence, and surrounded by a smooth or wrinkled membrane.

Multiplication takes place by subdivision and internal gemmation. Sexual union also takes place, the animals placing their anal apertures close to one another, and through these a protoplasmic bridge is formed, which unites the nuclei of the two individuals. Later at the points of contact the outlines of the two Noctilucæ fuse, and the nuclei become one. At last a large individual represents the two. Swarm-spores, which become tailed and ciliated and furnished with the tooth process, are formed within the united Noctilucæ and escape.

It is phosphorescent, rendering the sea luminous by night; but under the microscope the luminosity does not appear to be universal and uniform, but is dependent upon a number of repeated flashes. It is increased by physical and chemical agents.

BIBL. Quatrefages, *Ann. des Sc. Nat.* 3 sér. xiv.; Gosse, *Nat. Ramb. &c.*; Krohn, *Wiegmann's Archiv*, 1852; Huxley, *Micr. Journ.* 1855; Brightwell, *Ann. Nat. Hist.* 1850. vi.; *Micr. Journ.* v. 185; Pring, *Phil. Mag.* 1849; Cienkowski, *Schultz. Archiv*, 1871; Carus, *Man. Zool.*; Webb, *Qu. Mic. Jn.* vol. iii.; Busch, *Qu. Mic. Jn.* iii.

NODOSA'RIA, Lamk.—A subgenus of Hyaline Foraminifera. Shell elongate, straight, rounded, conical or cylindrical, with distinct or close-set chambers, smooth, ridged, or spined; orifice terminal, mostly produced and round (*N. raphanus*, Pl. 18. fig. 29). It passes by curvature into *Dentalina* &c., by eccentricity of aperture into *Marginulina* &c., and by compression into *Lingulina* and *Frondicularia*.

Found in Carboniferous and Permian rocks; abundant in the Trias and Lias, and in many strata of later date: living in many seas in rather deep water.

BIBL. D'Orbigny, *For. Foss. Vien.* 38; Williamson, *Rec. For.* 14; Morris, *Cat. Brit. Foss.* 37; Parker and Jones, *Ann. N. H.* 3. iii. 478; Carpenter, *Introd. For.* 161.

NODOSARI'NA, P. & J.—A genus (strictly a type species) of Hyaline Foraminifera. Its chief subgroups are *Nodosaria* and *Cristellaria*, which are one in essential characters of structure and mode of growth: *Glandulina, Lingulina, Dentalina, Rimulina, Vaginulina, Marginulina, Flabellina, Frondicularia,* and others are subsidiary forms. No line of division can be drawn between these approximate allies; for the straight, the curved, and the spiral lose themselves in each other—the amount of curvature and of spirality, and the greater or less closeness of the chambers and of the whorls being varying characters. The style of ornament, chiefly longitudinal ribbings, passing into spines and tubercles, is the same throughout

(see Pl. 18. figs. 28, 29, 30, 31, 32, 33, 34, 35, 37, 38, 39).

BIBL. Parker and Jones, *Ann. N. H.* 3. iii. 477; Carpenter, *Introd. For.* 159.

NŒMATE'LIA, Fr.—A genus of Tremellini (Hymenomycetous Fungi) distinguished by the presence of a central nucleus distinguished from the gelatinous surrounding substance. *N. encephala* is common in subalpine countries on larch rails, looking like a small brain, as the name implies.

BIBL. Fr. *Ep.* p. 591; Berk. *Outl.* p. 290; Cooke, *Handb.* p. 350.

NOLEL'LA, Gosse.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Vesiculariadæ.

Distinguished by the erect, subcylindrical cells, crowded on tubes forming an undefined incrusting mat; tentacles eighteen, forming a bell. One species:

N. stipitata.

BIBL. Gosse, *Mar. Zool.* ii. 21.

NONIONI'NA, D'Orb.—A subgenus of the Hyaline Foraminifera, subordinate to *Polystomella*. Shell nautiloid, usually symmetrical; many chambers, opening with a transverse slit at the base (*N. crassula*, Pl. 47. fig. 18). By septal modifications it passes into *Polystomella* (*P. striato-punctata*, and *P. crispa*, Pl. 47. figs. 19, 20).

Nonionina is not known for certain in strata older than the Chalk and the Tertiaries. It still abounds in shallow seas of temperate latitudes.

BIBL. D'Orbigny, *For. Foss. Vien.* 109; Parker & Jones, *Ann. N. H.* 3. v. 102; Carpenter, *Introd. For.* 286.

NORMANDI'NA, Nyl.—A genus of Pyrenodei (Lichenacei).

Char. Thallus squamose, squamulæ thin, rotundate. Apothecia black, immersed. *N. lætevirens*, Turn. & Borr., common on damp earth.

BIBL. Leighton, *Brit. Lich. Flora*, p. 408.

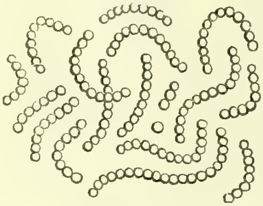
NOSTOC, Vaucher.—The typical genus

Fig. 527.

Nostoc commune.
Natural size.

of the Nostochaceæ, distinguished from the allied genera by the definitely formed hardened pellicle or rind enclosing the fronds, which are composed of a gelatinous substance (fig. 527) in which are imbedded numerous more or less beaded filaments (fig. 528). The filaments are composed of rows of cells (Pl. 4. fig. 7) which increase the length by repeated transverse subdivision;

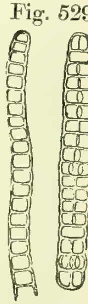
Fig. 528.



Nostoc cæruleum.
Filaments. Magnified 200 diameters.

here and there appear larger cells (*a*, *c*) which appear brighter than the rest; these seem to be what Kützing calls the *spermatia* or spermatic cells, but they more resemble the *vesicular cells* of the allied genera. The filaments break up after a time into short fragments, which by cell-division produce new filaments. Thuret has observed this process in *N. verrucosum* (*N. Mougeotii*, Bréb.); he states that the pellicle of the frond bursts, allowing the gelatinous mass to escape, and the filaments to spread abroad in the water; these are seen, by the aid of the microscope, to consist of short straightish pieces, which, as first observed by Vaucher, are endowed with the power of moving slowly along in the direction of their length; after a time they cease to move, and a new gelatinous envelope is formed around each piece like a transparent sheath. They soon become enlarged considerably, and then divide in the *direction of the length of the filament* (fig. 529), which becomes so disintegrated that the filament forms a spiral, by the increase of which through further transverse cell-division, the mass becomes confused, until the development of a greater quantity of the gelatinous matter makes the filaments more distinct. The same process was observed in *N. vesicarium*, D.C.; and Thuret con-

Fig. 529.



Nostoc verrucosum.
Filaments multiplying by subdivision.
Magn. 500 diams.

siders it likely that this mode of reproduction extends to the other species. We find that the gelatinous fronds break up when kept in water, and the colourless cells become green. Nothing is known of the import of the enlarged, brighter cells.

The resemblance of the Nostocs to the species of *Collema* (Lichens) has attracted much attention; and Braxton Hicks has shown that there is very strong evidence that the Nostocs are really the gonidia of Lichens. See his admirable notice in *Qu. Mic. Jn.* i. n. s. 1861, p. 90. The memoir of Sachs on this subject is deserving of attention.

The gelatinous fronds of the British species of this genus are found on damp ground, wet rocks, mosses, &c., and free or attached to stones, in fresh water (Pl. 4. fig. 7). The species are very numerous, and the following only can be noticed.

* *Frond globose or subglobose.*

1. *Nostoc minutissimum,* Kützing. Frond globose, from 1-30 to 1-4'''; filaments equal, deep æruginous green, densely entangled; periderm growing brown.

2. *N. lichenoides,* Vaucher. Fronds from the size of a mustard-seed to that of a pea, aggregated and heaped together; filaments equal, loosely entangled, æruginous or olivaceous; periderm pellucid, colourless, firm.

β. vesicarium; larger, soft, with a fuscous distinct periderm, mucous within, sometimes hollow.

3. *N. sphæricum,* Vaucher. Frond the size of a pea, firm, blackish æruginous or somewhat olive-coloured, soft within; filaments pale green, loosely entangled; periderm firm, colourless or fuscescent, subopaque. On stones in mountain rivulets. Meneghini states that, when dried and again moistened, it emits a pleasant odour like violets. Hassall thinks it probably an immature form of *N. foliaceum.*

4. *N. cæruleum,* Lyngbye. Frond from the size of a pea to that of a sloe (rarely larger), very soft and slimy, pale æruginous blue; filaments unequal, loosely entwined, joints oblong-elliptical; periderm colourless, pellucid, soft. Attached to mosses in flowing water or very moist places.

5. *N. pruniforme,* Agardh. Frond the size of a large round plum, deep æruginous green, very soft and watery within; filaments unequal, bright æruginous green, loosely entangled, joints subdepressed, dimidiate; periderm leathery, crystalline. Fronds unattached, in freshwater pools or rivulets.

** *Frond foliaceous, irregular, or vesicular.*

6. *N. foliaceum,* Agardh. Frond terrestrial, membranous, erect, plaited, olive-green; filaments slender, copious. On clayey ground constantly moistened by oozing water.

7. *N. commune,* Vaucher (fig. 527, & Pl. 4. fig. 7). Frond terrestrial, gelatinous, subcoriaceous, olivaceous or obscurely green, irregularly plaited; filaments nearly equal, flexuous, colourless or green, loosely entangled, the joints loosely conjoined, distant in one place, geminate in others, subspherical, depressed, marked with a central opaque spot; periderm hyaline, growing brown. Gravelly soils, garden walks, rocks, barren pastures, &c.; very common in autumn and winter.

8. *N. verrucosum,* Vaucher. Frond bladder-shaped, softly leathery, fuscous-green; filaments spiral, densely entangled, joints globose; periderm gelatinous, soft, green or dirty brown. On stones in streams.

9. *N. variegatum,* Moore.

Bibl. The works above quoted; Itzigsohn, *Bot. Zeit.* xii. p. 521 (1054); Sachs, *Bot. Zeit.* xiii. p. 1 (1855); Thuret, *Mém. Société de Cherbourg,* Aug. 1857, *Ann. Nat. Hist.* 3 ser. ii. p. 1; Thuret, *Mém. Soc. Imp. d. Cherbourg,* v. 1857; Fischer, *Beitr. z. Kennt. d. Nostoc. Bern.* 1853; B. Hicks, *Qu. Mic. Jn.* 1861, ii. p. 90; De Bary, *Regensb. Flora,* 1863; Rabenh. *Fl. Eur. Alg.* ii. 161.

NOSTOCHA'CEÆ.—A family of Confervoid Algæ, composed of plants forming gelatinous strata or definitely formed gelatinous balls or masses, either on damp ground or floating at the bottom of water; consisting of minute, unbranched, usually moniliform, microscopic filaments, tranquil or oscillating, imbedded in a mass of mucilaginous or sometimes firmish substance (the amorphous matrix is produced by the fusion of the special gelatinous sheaths of the individual filaments); filaments finally breaking up. Cells of the filaments of three kinds:—1. *ordinary* cells; 2. *vesicular* cells or *heterocysts,* usually large and without granular matter, frequently with erect hairs; 3. *sporangia* or *sporangial* cells, produced by the enlargement of the ordinary cells, globular, elliptical or cylindrical. The reproduction by spores has been observed in *Cylindrospermum* by Thuret, who finds that the *sporangial cells* produce in their interior one thick-coated spore, which, after a season of rest, germinates and breaks out from the sporange to grow into a new cellular filament.

Rabenhorst divides the family into the subfamilies Nostoceæ and Spermosireæ—the first being destitute of spores, and the last possessing them. The Nostoceæ include the genus *Nostoc*, and the Spermosireæ the genera *Anabæna, Spermosira, Cylindrospermum, Sphærozyga.* The genera *Aphanizomenon* (Allman) and *Dolichospermum* (Thwaites) are absorbed in the last-named genus. *Trichormus* (Allman) should occur in these also.

See reference to Braxton Hicks's views in NOSTOC. Lately McNab has exhibited the occurrence of Nostochaceous filaments in the tissue of *Azolla*, one of the Marsiliaceæ.

BIBL. Ralfs, *Ann. Nat. Hist.* 2 ser. vol. v. 321, pls. 8 & 9; Kütz. *Tab. Phycol.* i. pp. 91–100, ii. pls. 1–15; Thuret, *on Nostoc, Ann. des Sc. Nat.* 2 sér. t. ii.; Meneghini, *Monog. Nostoch. Mem. Turin Acad.* ser. 2. v. 1843; Allman, *Micr. Jn.* 1855; Rabenh. *Fl. Eur. Alg.* ii. p. 161; McNab, *Qu. Mic. Jn.* 1874, p. 215.

NOTA'MIA, Flem.—A genus of Infundibulate Cheilostomatous Polyzoa, of the family Gemellariadæ.

Char. Cells placed back to back, facing opposite directions; tobacco-pipe-shaped bird's-heads above each pair. One species:

N. bursaria (Pl. 44. fig. 21). An elegant microscopic object.

BIBL. Johnston, *Brit. Zooph.* 294; Busk, *Cat. Mar. Polyz.* (*Brit. Mus.*) 36.

NOTE'US, Ehr.—A genus of Rotatoria, of the family Brachionæa.

Char. Eyes absent, foot forked (=eyeless *Brachionus*).

N. quadricornis (Pl. 35. fig. 13). Carapace suborbicular, depressed, scabrous, areolate, with four spines in front, and two behind; aquatic; length 1-10 to 1-70″.

BIBL. Ehr. *Infus.* p. 502; Pritch. *Infus.* 707.

NOTODEL'PHYS, Allm.—A genus of Entomostraca, of the order Copepoda.

N. ascidicola (Pl. 14. fig. 22) resembles *Cyclops* in general appearance. The external ovary is a single organ, lying across the back of the abdomen; eye single. Marine.

BIBL. Allman, *Ann. Nat. Hist.* xx. p. 1; Baird, *Brit. Entom.* p. 237.

NOTO'DROMAS, Liljeborg.—An Ostracode related to *Candona*, among the *Cypridæ*. It has long setæ on the lower antennæ, and two eyes. Its carapace has a flat ventral surface with limiting ridges; and with this portion upwards it floats at the top of sunny pools in Europe and the British Isles (*N. monachus*, Müller), and in Australia (*N. fenestrata*, King).

BIBL. G. S. Brady, *Tr. Linn. Soc.* xxvi. 379.

NOTOGO'NIA, Perty.—A genus of Euchlanidota (Rotatoria).

Char. Body covered with a lorica, which dilates posteriorly. Posterior margin with two pointed processes on each side. Two eyes widely separated on the outer margins of the anterior extremity. Jaws curved, strong, with two or three teeth. Caudal setæ strong.

BIBL. Pritchard, *Infus.* 700.

NOTOM'MATA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Free; eye single, cervical; tail-like foot with two toes; rotatory organ simply ciliated.

In some the rotatory organ is extended laterally in an ear- or arm-like form.

Ehrenberg describes twenty-three species, some of which are parasitic, *N. petromyzon* and *parasita* living within *Volvox globator*, and *N. werneckii* within the vesicles of *Vaucheria*; and divides them into the subgenera:—*Labidodon*, jaws each with a single tooth; *Ctenodon*, jaws each with several teeth.

Notommata granularis is the male of *N. Brachionus.*

Many of the species are large and well adapted for the study of the internal structure.

N. centrura (Pl. 35. fig. 14; 15, jaws and teeth). Body attenuate at each end, foot small and hard; cephalic auricles short; no lateral setæ; aquatic; length 1-36″.

BIBL. Ehr. *Infus.* p. 424; Duj. *Infus.* p. 646; Pritchard, *Infus.* 681.

NOTONEC'TA, L.—A genus of aquatic Hemipterous insects.

Fig. 530.

Notonecta glauca.
Magnified 3 diameters.

The insects belonging to this genus have

the elytra membranous in the posterior part, and the body is more or less boat-shaped. The hind legs are very long, and when stretched out resemble and act as a pair of oars. The *Notonectæ* swim on their backs, and generally in a slightly inclined position, on the surface of ponds and ditches. They descend with great rapidity. They are very voracious, and live on aquatic larvæ, biting also very sharply. Their mouth-pieces and limbs afford interesting microscopic objects.

N. glauca (the water-boatman) is common in pools.

NUBECULA'RIA, Defrance.—An Imperforate Foraminifer; shell opaque, often sandy, protean, parasitic on shells and algæ; straight, scale-like, or cervicorn; chambers with imperfect base; at first spiral; aperture oval, produced, often lipped. Fossil in the Trias, Oolite, and Tertiaries; common in shallow waters of warm latitudes (*N. rugosa*, Pl. 18. fig. 21).

BIBL. Jones & Parker, *Q. J. Geol. Soc.* xvi. 455; Carpenter, *Introd. For.* 69.

NUCLEUS AND NUCLEOLUS OF ANIMALS.—The nucleus and nucleoli of animal cells have been described (see CELL, p. 132); and it is only necessary to notice that Van Beneden has described the nucleus in the granular cell-contents of a large *Gregarina*. It has normally a regular ellipsoid form; and its dimensions vary with those of the *Gregarina*. This nucleus has a membrane, and is not a solid body destitute of one; the membrane is very thin, and permits of modification in the form produced by pressure, but not spontaneously. The nucleoli appear and disappear, enlarge and diminish, and vary in number. *Qu. Mic. Jn.* 1870, p. 54.

In morbid anatomy it is evident that *fission of the nucleus* of a cell is a common process in most cases of cell-development. The nucleus becomes lengthened, narrowed at its middle, and exhibits an hour-glass constriction until the halves separate from one another, and two nuclei take the place of one. Nucleoli take part in this process, and are to be seen in the large vesicular nuclei of cancer-cells. The fission takes place with great rapidity, and can rarely be observed. Moreover the hour-glass constriction may cease, and the nucleus may return to its original shape. Increase in the amount of protoplasm surrounding the nucleus accompanies the fission. In endogenous cell-formation the nucleus divides, and the protoplasm groups itself around the newly formed nuclei, but the resistance of the limiting membrane of the cell prevents the separation of the independent segments. A parent cell containing daughter cells results; but often nuclei are found therein without an aggregate of protoplasm around them. In nucleated protoplasm, which is the result of granulation after inflammation, the nuclei are massed together and separated and encircled with protoplasm, in which limiting cell-membranes are invisible. Fission of the nuclei takes place, and the separated ends gradually become wider apart by the aggregation of protoplasm.

NUCLEUS and NUCLEOLUS OF PLANTS.—The term nucleus is applied in botany to two very different things—first to the central body of the young ovules of Flowering plants, and secondly to a peculiar structure met with in the interior of cells (the cytoblast). The first will be described under the head of OVULE; the cell-nucleus and nucleolus mentioned in the article CELL (*Vegetable*) will be discussed here.

Few parts of the minute organization of plants are more obscure than the structure and function of nuclei: some authors regard them as of the highest physiological importance; others consider their import altogether unknown. The nucleus may be observed most easily in the parenchymatous cells of the herbaceous structures and flowers of Monocotyledons (Pl. 37. fig. 28 *b*), or in the young cells of the hairs of Flowering plants generally (Pl. 38. figs. 8, 9 *b*), or in the embryo-sacs of ovules (Pl. 38. figs. 4–6); in such cases the characters are well defined and unmistakable. It consists of a lenticular body formed of more or less granular protoplasm, with one or more well- or ill-defined bright points, cavities, or solid substances (*nucleoli*) in the interior. Wherever it appears throughout the higher plants, it seems to possess the same characters; but it may be absent on the cells of many Algæ, Lichens, and Fungi.

Ordinarily nuclei are found attached to the side of cells, or forming the centre of radiating protoplasmic filaments (Pl. 38. fig. 9): sometimes, however, the nucleus is suspended in the middle of the cavity of the cell by filamentous processes of protoplasm; in all such cases it forms a kind of centre for the circulation of the protoplasm where this exhibits movement (ROTATION), and it is itself carried about to a certain extent by the currents.

The gradual transfer of the nucleus to the sides of the cell may be well seen in the

hairs of the stamens of *Tradescantia* (Pl. 38. figs. 8, 9). In *Spirogyra* and *Zygnema* the nucleus always remains suspended in the middle of the cell by the protoplasmic cords. The ultimately parietal nucleus of the hairs of *Tradescantia* exhibit radiating cords, the protoplasm being in process of absorption. In *Vallisneria* and *Œdogonium* and other Confervoids, the nucleus becomes imbedded in the continuous parietal layer of protoplasm which lies upon the so-called primordial utricle.

The *nucleoli* (Pl. 38. fig. 8 *n*) of these larger nuclei are apparently usually more or less solid granules of a transparent substance, but sometimes they appear more like minute cavities.

The nuclei and nucleoli of the lower plants are exceedingly obscure; in a great many cases the so-called nuclei are little different from the nucleoli of the larger forms, occupying to the entire cell-contents the same relation as the nucleoli to large nuclei, for example, in the spores of Lichens (Pl. 29. fig. 7), Fungi, &c. In the lower Confervoid Algæ the nucleus (or nucleolus) appears to be represented by the entire cell-contents (Pl. 3), in which one or more well-defined granules often occur, representing nucleoli; in certain stages, however, a larger granule is met with, coloured by chlorophyll, which some regard as a nucleus; this disappears totally at particular epochs, and is replaced by starch-granules or oil-globules. The bright-coloured point, or 'eye-spot,' seen very generally in the Zoospores both of Confervoids and Fucoids, may represent a nucleolus.

Nuclei originate in two ways. The simplest mode is found where they precede free-cell formation, as in the development of the germinal vesicles in the embryo-sacs of Flowering plants. Here the nuclei appear first as globular, granular, or lenticular masses, which become gradually defined in the substance of a collection of protoplasm accumulated at the upper end of the cell (Pl. 38. figs. 1–4). This is a spontaneous isolation of a portion of the protoplasm to become the foundation of a new cell. We may compare this with the segmentation of the entire mass of contents of the cells of Confervæ in the formation of Zoospores, which may perhaps be regarded as at first free *nuclei*. In cells multiplying by division, a division of existing nuclei has been observed to take place in certain cases, as in the hairs of *Tradescantia* (Pl. 38. figs. 8 & 9); but in other similar cases of division no nuclei are observed (Pl. 38. figs. 10 & 11). In the case of *Tradescantia*, the oval parent nucleus fills up the end of the growing cell, so that the division of the nucleus is almost synonymous with the division of the primordial utricle. But in this case, as in the development of cells from free nuclei, as indicated in the germinal vesicles, the cell-membrane in expanding draws away from the nucleus, which remains adherent to or suspended in connexion with a layer of protoplasm lining the cell-wall and forming its primordial utricle. In Spirogyra and *Zygnema*, a division of the free suspended nucleus precedes the division of the large primordial utricle.

Mohl describes a division of nuclei as occurring in *Anthoceros*; and most authors who have written on the development of pollen and spores lay great stress on the influence of the nuclei, which they describe; but the import of nuclei in vegetable cells is certainly still a problem. Some believe they are the universal agents of production of new cells, others that they are not the agents of this in any case, but, when present, may be divided with the cells. Others imagine that they are merely the original "mould" of protoplasm on which the cellulose membrane of the nascent cell is deposited, and which is left unaltered when this expands (the phenomena in *Spirogyra* are opposed to this). Some of those who deny their influence in cell-development believe them to be the vital centres of the cells in which they exist.

They are best seen in very young cells in all cases; in nascent tissues they almost or quite fill the cavity of the young cells. As the cells grow older, their history differs in different cases. Sometimes they persist until the decay of the organ in which they exist. This happens very generally in the cells of the flowers, stems, &c. of Monocotyledons; not unfrequently, in stems and leaves they become converted into starch or chlorophyll granules. In other cases they have a more definite purpose; for in the vesicles in which are formed the Spermatozoids of Ferns, Mosses, Hepaticæ, Characeæ, &c., these structures appear to be produced by a metamorphosis of the nuclei.

In examining supposed nuclei of plants, especially those of lower cellular organization, tincture of iodine should always be applied, to distinguish starch-granules &c. from true nuclei, which are always coloured

deep yellow or brownish by that reagent, besides being coagulated, contracted, and thereby rendered more distinct.

BIBL. R. Brown, *on Orchidaceæ, Phil. Mag.* Dec. 1831; Nägeli, *Zeit. f. wiss. Bot.* (transl. in *Ray Soc. Vols.* 1845 & 1849); Mohl, *Pflanzenzelle*, pp. 36 and 51; Hofmeister, *Entsteh. d. Embryo*, Leipsic, 1849, p. 7; Al. Braun, *Verjüngung* (*Ray Soc. Vol.* 1853, p. 175).

NUMMULI'NA, D'Orb. } A Hyaline Foraminifer of the highest class.
NUMMULI'TES, Lamk. }

Shell lenticular, varying in convexity and in size (from less than $\frac{1}{30}$ to $2\frac{1}{2}$ inches in diameter), composed of several, overlapping, uniform, whorls of numerous >-shaped chambers in a discoid spire. These are prolonged towards the umbo of each face, thus forming Alar Lobes, either straight (in the *Radiatæ*), or sinuous (*Sinuatæ*), or inosculating (*Reticulatæ*). The alæ are abortive or absent, and the spire therefore exposed, in *Assilina* and *Operculina*, unequal and modified in *Amphistegina*. The chambers communicate by a transverse slit at the base of the septum, with smaller occasional holes. The outer chamber-walls (Spiral Lamina) are thin in the latest, but in the older chambers thickened by successive layers of the delicate tubuliferous shell. Over the septa of the median plane (Pl. 47. fig. 22), and where the alar septa cross and touch, the tubuli being obsolete, the shell becomes translucent (Pillars); at the outer margin (Marginal Cord) also of the whorls the layers of shell become translucent, and are traversed by radiating and inosculating tubes, continuous with canals passing between the two shell-layers of each septum (Interseptal Canals), and with the canals in the margin of the inner whorls. This Canal-system carries spiral and branching threads of sarcode through the denser parts of the shell, which, indeed, in some *Polystomellæ* and *Calcarinæ* appear to be secreted thereby (Supplementary Skeleton).

Nummulina is rare in the Carboniferous, Jurassic, and Cretaceous, but very common in the Lower Tertiary strata; living in the North, Red, and Australian seas, but small (*N. radiata*, Pl. 47. fig. 21).

BIBL. D'Archiac et Haime, *An. foss. Num. Inde*, 1853; Carter, *Ann. N. H.* ser. 2. xi. p. 161, and ser. 3. viii. pp. 320, 366; Parker and Jones, *Ann. N. H.* ser. 3. v. p. 106, viii. p. 229; Carpenter, *Introd. For.* p. 262; *Microscope*, 1858, p. 510; H. B. Brady, *Ann N. H.* ser. 4. xiii. p. 222.

NYC'TALIS, Fr.—A genus of Agaricini (Hymenomycetous Fungi), consisting of one or two species, parasitic on *Russulæ*, with thick obtuse gills, of which *N. parasitica* is the type. *N. asterophora* is constantly infested with dusty, fawn-coloured, echinulate spores, which are a peculiar condition of a species of *Hyphomyces*.

BIBL. Fr. *Gen. Hym.*; Berk. *Outl.* p. 217; Cooke, *Handb.* p. 231; Tul. *Carp.* i. p. 109, iii. p. 54.

NYMPHÆACEÆ. See HAIRS (p. 366).

O.

OAT, *Avena sativa* (Nat. Order Graminaceæ, Flowering Plants).—The form of the starch-corpuscles of the oat is very unlike that of the other common corn-plants; they consist of numerous small polygonal grains grouped together in roundish or oval masses (Pl. 37. fig. 10). See STARCH.

OBE'LIA, Péron & Lesueur.—A genus of Campanulariidæ (Hydrozoa).

Char. Stem branching, plant-like, rooted by a creeping stolon; hydrothecæ campanulate, without operculum; gonothecæ on the stems and branches; reproduction by free medusiform zooids. Gonozooid: umbrella depressed and disk-like; manubrium short and quadrate; radiating canals four; marginal tentacles numerous; lithocysts eight, two in each interradial space.

BIBL. Hincks, *Brit. Hyd. Zooph.* p. 147.

OBISIDA. See ARACHNIDA, p. 65.

OBJECTIVE, OBJECT-GLASS. See INTRODUCTION, p. xv.

Immersion-system.—The loss of light dependent on the reflection of a portion of the oblique rays from a surface of glass, whether they are entering or are quitting that surface, is much less when they pass from water into glass than from air into glass; or *vice versâ*, from glass into water than from glass into air.

Acting upon these facts, Amici, in the first substance, and subsequently Hartnack, Nachet, Gundlach, and most of the great English objective-makers formed and corrected object-glasses so that they could be used when the distal surface of the exposed lens was immersed in water. The diminution of the loss of light is great; and when properly corrected the immersion-lenses can be used as successfully and much more readily than object-glasses of the same magnifying-power used in the usual " dry "

manner. Consult Carpenter, *Microscope*, 4th edit. 1868; Frey, *Das Mikros.* p. 40; and Beale, *How to Work*; Royston Pigott, *Qu. Mic. Jn. & Mo. Mic. Jn.*, passim; Brakey, *Month. Mic. Jn.* May & June 1874.

OCEL'LI.— Eye-specks, pigment-spots, and true, "simple," and small visual organs in the Invertebrata. The ocelli of the Medusidæ are situated around the circumference of the disk, and consist of little aggregations of pigment enclosed in cavities. In the Echinida the ocellus occupies a pore in each of the ocular plates at the summit of the ambulacral areas; and the Asteriadæ have a pigment-spot at the extremity of each ray, this rudimentary organ being surrounded in some species by movable spines. In the Annuloida, *Planaria* has from two to sixteen pigment-spots or rudimentary eyes in the preoral region of the body; the Anguillidæ also have pigment-spots; and Rotifera have red pigment-spots or a spot situated in close contiguity to the nervous mass. Numerous ocelli are found in many species of Annulata—in the Leech for instance, and in the Errantia also, whilst some of these have them not. The Chætognatha have imperfect but darkly pigmented ocelli, resting on ganglia. See CRUSTACEA, ARACHNIDA, INSECTA. Minute ocelli occur along the margins of the mantle of some Lamellibranchiata, and between the oral tentacles of the Tunicata. In the Gasteropoda and Cephalopoda the non-compound organs of vision become true eyes. In every instance these ocelli, whether they are truly optical organs or not, afford interest to the microscopist.

OCHLOCHÆTE, Thwaites.— Is now included in the APHANOCHÆTE.

OCTAVIA'NA, Tul.—A genus of Gasteromycetous Fungi (section Hypogæi) distinguished by the sterile base of the continuous or cracked peridium; the easily divisible byssoid frames and the fruit-bearing cavities at first empty, then covered with the rough spores.

BIBL. Tul. *Fung. Hyp.* t. ii. f. 1; Berk. *Outl.* p. 292; Cooke, *Handb.* p. 355.

OCTOSPORES.—Sporangia of Fucaceæ, which subdivide into a cluster of eight cells.

ODONTEL'LA, Ag. — This genus of Diatomaceæ is united with BIDDULPHIA, *Biddulphia* (*Odontella*) *aurita* undergoing spontaneous division, Pl. 14. fig. 9.

ODONTHA'LIA, Lyngb.— A genus of Rhodomelaceæ (Florideous Algæ) containing one British species, *O. dentata*, which has an irregularly bipinnatifid frond, 3 to 12″ long, the main axis and lobes being about 1-4″ wide throughout; the colour is deep wine-red, darker when dried. The frond bears marginal, stalked, ostiolate, ovate *ceramidia* with spores, lanceolate *stichidia*, in which are contained two rows of ternate tetraspores, and *antheridia*.

BIBL. Harv. *Brit. Alg.* p. 77, pl. 11 A; *Phyc. Brit.* pl. 34; Greville, *Alg. Br.* pl. 13, Kütz. *Phyc. generalis*, p. 448.

ODONTID'IUM, Kütz. — A genus of Diatomaceæ.

Char. Frustules quadrangular, united to form an elongated biconvex filament; linear in front view; valves elliptical with transverse continuous striæ. Aquatic and marine.

Differs from *Denticula* in the elongated filament, which sometimes, however, consists of only three or four frustules!

O. turgidulum (Pl. 13. fig. 14: *a*, front view; *b*, side view). Valves lanceolate, obtusish; striæ on each valve six. Aquatic; length of frustules 1-1720 to 1-570″.

O. tabellaria, Smith = *Staurosira construens*, Ehr. (Pl. 41. fig. 38).

BIBL. Kütz. *Bacill.* p. 44; *Sp. Alg.* p. 12; Smith, *Brit. Diat.* ii. 15; Rabenh. *Fl. Eur. Alg.* i. 116.

ODONTODIS'CUS, Ehr.—A genus of Diatomaceæ. See COSCINODISCUS.

Char. Frustules single, lenticular; valves circular, alike, without nodules or apertures, not areolar (under ordin. illum.), but covered with puncta either arranged in radiating rows or in excentrically curved lines, and with erect marginal teeth.

The puncta are surely the ordinary depressions imperfectly examined. Three species; fossil and in guano.

O. eccentricus (Pl. 43. fig. 52).

BIBL. Ehr. *Ber. d. Berl. Akad.* 1844, p. 73; Kütz. *Sp. Alg.* p. 129; Pritchard, *Infus.*

ODONTOPHORE.—The so-called tongue of some mollusca (the *Odontophora*); it is a cartilaginous cushion supporting, as on a pulley, an elastic strap, which bears a long series of transversely disposed teeth. See TONGUE, Molluscan.

BIBL. Huxley, *Elem. Comp. Anat.*

ODONTOTRE'MA, Nyl.—A genus of Lichenacei.

Char. Thallus indistinct. Apothecia black, naked, at first closed, then dehiscing with a denticulato-ruptured proper margin.

O. longius, Nyl. On old nails, England and Europe.

BIBL. Leighton, *Brit. Lich. Flora*, 358.

ŒCIS'TES, Ehr.—A genus of Rotatoria, of the family Œcistina.

Char. Single; rotatory organ single, with an entire margin; body attached to the bottom of a fixed cylindrical carapace; eyes two, frontal, red, disappearing in advanced age.

O. crystallinus (Pl. 35. fig. 16). Carapace hyaline, viscid, covered with foreign bodies; aquatic; entire length 1-36″.

Jaws each with three teeth.

Bibl. Ehr. *Infus.* p. 392; Pritchard, *Infus.*; Davis, *Mic. Trans.* 1866, p. 14.

ŒCIS'TINA, Ehr.—A family of Rotatoria (small *Melicertæ*, probably).

Char. Animals single or aggregate, attached to the bottom of a gelatinous carapace; rotatory organ single, with an entire margin.

A distinct carapace for each animal ... 1. *Œcistes.*
Carapaces aggregated into a sphere ... 2. *Conochilus.*

Bibl. Ehr. *Infus.* p. 391.

ŒDE'MIUM, Fr.—A genus of Dematiei (Hyphomycetous Fungi). *Œ. atrum*, Corda, consists of dense tufts of brown erect fibres, scarcely branched, and without true septa. The roundish "spores" are sessile upon the sides of the erect filaments.

Bibl. Corda, *Sturm's Deutschl. Fl.* 6, pl. 9; Fries, *Systema Mic.* 344; Berkeley and Broome, *Ann. N. H.* 2 ser. vi. p. 466.

ŒDIPO'DIUM, Schwägr.—A genus of Splachnaceæ (Acrocarpous, operculated Mosses), sometimes included under *Gymnostomum*. *Œdipodium Griffithianum*, Schwäg., the only species, is remarkable for the peculiarly thickened fruit-stalk, whence the name of the genus is derived.

ŒDOGONIA'CEÆ.—A family of filamentous Confervoid Algæ, remarkable for the filaments growing by a peculiar mode of cell-division, accompanied by circumscissile dehiscence of the parent cell, and by the zoospores being formed from the whole contents and bearing a crown of numerous cilia. There are two genera:

1. *Œdogonium.* Filaments unbranched.
2. *Bulbochæte.* Filaments branched and bearing bristle-cells with a bulbous base (fig. 83, p. 117).

Bibl. See the genera.

ŒDOGO'NIUM, Link. (*Prolifera*, Leclerc, *Vesiculifera*, Hass.).—A genus of Œdogoniaceæ (Confervoid Algæ). Some of the *Œdogonia* are among the commonest and most abundant of freshwater Algæ, occurring in every pond, ditch, or stream, and quickly making their appearance in tanks, aquaria, &c. They may generally be recognized at a glance by the dense and uniform green protoplasm, sometimes filling the cells, sometimes (after dividing) leaving half of the cell colourless and devoid of chlorophyll—above all, by the annular striæ occurring at the ends of many of the cells (Pl. 5. fig. 7 *b, h*). The cells have each a large parietal nucleus (fig. 7 *a*). The large round interstitial sporangial cell (fig. 7 *g*) is also a very distinctive character. The zoospores also are peculiar, consisting of the entire contents of a cell, therefore very large, and are crowned with a wreath of cilia (Pl. 5. fig. 7 *c*). The filaments are attached, when young, to stones, plants, &c. by root-like processes. The filaments are composed of rows of cylindrical cells, which multiply interstitially in a very curious manner. When a cell is about to divide, an annular deposit of cellulose occurs around the upper part of the parent cell. Next the wall of the parent cell breaks, by a circumscissile dehiscence, just below the cellulose ring. The internal cell elongates and removes the margins of the circular slit from each other, the upper piece of the parent-cell wall being pushed up as a kind of cap on the elongating cell. While the cell is thus being elongated, its primordial utricle becomes divided below the line of dehiscence of the parent cell; but both the new portions grow, so that the line of division between the two new cells at length rises above the margin of the lower part of the parent cell. The annular deposit of gelatinous cellulose has meanwhile become stretched or developed over the space left by the separation of the halves of the parent membrane, forming an outer coat to the new cell. After the growth of the lower cell is finished, the upper one begins to elongate, until it attains equal length; it remains poor in protoplasm and chlorophyll while growing, but becomes densely filled when it has attained its full dimensions. The margins or broken ends of the parent-cell wall form the annular striæ seen on the filaments (Pl. 5. fig. 7 *b, g, h*): at first there is only one at the top of any given cell; but the next dehiscence takes place just below this, giving rise to a second, and so on, until many successive rings are produced at one spot.

The zoospores or ciliated gonidia (fig. 7 *c*) are formed from the entire contents of a cell, and exhibit a large round nucleus; they escape by a circumsciss le dehiscence

of the wall of the parent cell (*b*): the filament, however, does not generally become quite broken in two; the portions remain attached by a strip of the side-wall forming a kind of hinge; and the zoospores are not set free directly, but at first are enclosed in a very delicate and almost imperceptible globular envelope, colorable blue by iodine and sulphuric acid, which appears to dissolve very quickly in the water. The zoospores are large, somewhat ovate in form, with a transparent region at one end, whence the numerous cilia arise. When expelled, they move for a time, and then come to rest, attaching themselves to foreign objects by the ciliated end, acquiring a membrane, sending out root-like processes below (*e*), and elongating and expanding above into a longish pear-shaped body. Sometimes the zoospores do not completely extricate themselves from the parent cell, and then germinate in this way *in situ*, the root-like processes remaining engaged in the parent cell. Very often they attach themselves upon the parent filament to germinate. The next stage after germination presents two different classes of phenomena: in the one case, as a purely vegetative zoospore, the young plant elongates gradually into a jointed filament by extension and cell-division; in the other it is an *androspore*, and becomes an *antheridial* filament.

The *Œdogonia* produce large resting-spores (*oospores*), which are formed from the entire contents of the uppermost of two cells developed as above described. A rupture of the parent-cell wall takes place at the side during the development of the spore; through the small orifice thus formed the spore-mass becomes fertilized through the agency of the little globular bodies produced in the antheridia (Pl. 45. figs. 5, 16, 17). Ultimately the spore, while increasing in size, retracts itself from the walls of its parent cell (*oogonium*), and lies free in the cavity, presenting a double coat, the outer of which is thick and tough; its contents acquire a red colour as it ripens. The parent cell of the spore mostly acquires a globular or elliptical form, and a red or brown colour, appearing like a kind of nodule on the filament; and the ripe spore, of globular, elliptical, or depressed spherical form, is mostly of greater diameter than the ordinary cells (Pl. 45. fig. 21). The ripe spore, which is quadruple, escapes by the decomposition or dehiscence of the parent cell, and is covered with a hyaline membrane. Each of the four spores is likewise surrounded by its cell-membrane. After a short time has elapsed, the hyaline membrane disappears, and the four spores lie still and motionless. Then a change sets in: the cell-membrane of each spore bursts by means of an annular slit, and a part separates like a lid. Soon the cell-contents leave the cell in the form of a zoospore, which moves with the aid of a crown of cilia. After a certain time the motion ceases, the cilia disappear, and one end of the zoospore becomes elongated into a root like the ordinary zoospores. The little cell thus fixed becomes divided by a transverse septum. Each spore thus produces four *Œdogonium* plants.

The antheridial structures of the *Œdogonia* are either formed in the ordinary filaments (Pl. 45. fig. 13), or from dwarf filaments produced from the smaller zoospores or *androspores* (Pl. 45. fig. 19). In either case they consist of one or more very short joints of the filament, formed in the ordinary way, the contents of which divide into two portions. The cells then dehisce and allow the new products to escape, which resemble the vegetative zoospores, but are much smaller. These new bodies, the spermatozoids, make their way through the orifices in the parent cells of the spores and fertilize their contents (Pl. 45. fig. 20).

The *Œdogonia* appear to be sometimes purely monœcious or diœcious, the single filaments including either both antheridial and spore-cells, or only one kind of organ; but the most common condition is intermediate between these two conditions, the filaments having some joints converted into sporangial cells, others giving birth to the androspores, which germinate into dwarf antheridial filaments (often sessile on or near the sporanges); and these produce spermatozoids. This condition is termed by Pringsheim *gynandrosporous*.

Bibl. Mohl, *Bot. Zeitung*, xiii. p. 689; De Bary, *Soc. des Sc. Nat. d. Fribourg*, July 1856; Carter, *Ann. Nat. Hist.* 3 ser. i. p. 29; Hassall, *Freshw. Alg.*; Braun, *in Kütz. Spec. Alg.*; Rabenh. *Fl. Eur. Alg.* iii. 347; Juráni, *in Pringsheim's Jahrb. f. wiss. Bot.* 1873.

OID'IUM, Link (*Acrosporium* and *Sporotrichum*, Greville; *Torula*, Corda).—A supposed genus of Mucedines (Hyphomycetous Fungi), but very probably consisting merely of imperfect conditions of plants of more complex nature. The *Oidia* have recently attracted great attention on account of the

extraordinary development of the form called *Oidium Tuckeri* on the vines of Europe and the Atlantic islands. This, however, like *O. leucoconium* and others, appears to be only the conidiiferous mycelium of an Erysiphe or some allied plant; the particulars of its history are given more at length under Vine-fungus. *Oidium lactis* seems also referable to *Torula*, or to the mycelium of Penicillium. *O. abortifaciens*, Lk. is an imperfect state of Claviceps; *O. albicans*, C. Robin, the fungus of Aphtha, is probably referable to some other genus when mature, as *Achorion* should perhaps also be included under *Puccinia*. The objects described as *Oidia* consist of delicate horizontal filaments, creeping over leaves, fruits, or decaying vegetable and animal substances (*O. lactis* at the edges of sour milk, *O. albicans* in the mouth of the human subject), forming an interlaced fleecy coat, the horizontal filaments giving origin to numerous erect (usually short), articulated pedicels, the uppermost cells of which (or several of the uppermost) become expanded into oval bodies (*conidia*) which become disarticulated, and, falling upon the matrix, germinate and produce new filaments (Pl. 20. figs. 8, 9).

Oidium leucoconium, Tuckeri, erysiphoides are white; *O. aureum, fulvum, fructigenum*, and others subsequently become coloured, and these certainly belong to a different category.

Bibl. Berk. *Hook. Brit. Fl.* ii. pt. 2. p. 349; *Ann. Nat. Hist.* i. p. 263, vi. p. 438, 2 ser. vii. p. 178, xiii. p. 463; *Crypt. Botany*, pp. 300, 308; Fries, *Summa Veg.* 494; Fresenius, *Beitr. z. Mycol.* H. i. p. 23, ii. p. 76; Léveillé, *Ann. des Sc. Nat.* 3 sér. xv. p. 109; Grev. *Sc. Crypt. Fl.* pl. 73; Ch. Robin, *Végét. Parasit.* 2nd ed. p. 488; and the *Bibl.* of Vine-fungus.

OIL.—Oils of various kinds are most abundantly produced by a very large number of plants, and occur to some extent in almost all. For the microscopist, it is convenient to divide them into *essential* and *fixed* oils. The former are special secretions, and occur in the cells of the Glands and Glandular Hairs of the epidermis of those parts of plants exposed to the air and light. Fixed oils are found principally in the cells of tissues still physiologically active in the nutrition of the plants, and they appear in many cases to have a close relation with and to form substitutes for starch. Thus fixed oils occur stored up in the cells of the perisperms or of the cotyledons of certain seeds in which little or no starch is produced, as in the *Papaveraceæ*, *Cruciferæ*, *Linum*, the almond, nut, &c. Oil may occur also in the pulp of fruits, as in the olive.

Spores of Cryptogamic plants and Pollen-grains are remarkable for the oil they exhibit in their mature condition. It appears to serve as an indifferent or inert form of assimilated nutriment.

Oil occurs in the cavity of cells in the form of minute drops, which may be distinguished mostly, by the experienced microscopist, by simple inspection; but it is often desirable to prove the nature of the globules, which may be done by removing them with ether, or, in the case of pollen, by viewing them in spirit of turpentine or oil of lemons. Potash does not act readily upon oil-globules in the cells of plants.

In certain cases it is convenient to view objects in oil instead of water, in order to render them more transparent; for this purpose oil of lemon or turpentine is usually employed. See Preparation.

OLFACTORY ORGAN.—The region of the organ of smell which is more particularly devoted to the reception of the sensation is a part of the mucous membrane, which possesses either a yellowish or a brownish tint. It is termed the regio olfactoria. If sections be made of the mucous membrane hardened in solution of chloride of gold, and they be carried down to the bone, it will be found that the osseous structure is invested with a periosteum which is immediately covered with a thick layer of numerous and closely arranged glands—the glands of Bowman. They are elongated and often flask-shaped. The glands contain an epithelium, which is spherical near the fundus and polygonal towards the excretory duct. The ducts reach the surface between the elements of the next following external layer. They are separated from each other by ordinary connective tissue, which is connected below with the periosteum and above with the epithelium, the most external layer. But it does not appear that a basement membrane exists to this last. Imbedded in the connective tissue are the vessels and the ramifications of the olfactory nerves. The superficial layer of the mucous membrane is an epithelium which, under chloride-of-gold solution, is divisible into two—an external, which is finely striated, and an

internal granular layer. When the olfactory organ of a Proteus is treated with chloride-of-gold solution for a day, and then a fragment torn off and teased out, the epithelial cells split up into distinct cell groups. The external half is composed of extremely long fibrils, which at their outer extremities terminate in long cilia; and the internal half consists of large compressed nuclei, of which one, larger than the remainder, presents an elongated form, and is for the most part situated externally. Each of the above groups consists of two kinds of cells, some few of which are large, whilst the greater number have a large round nucleus and very long fine processes. One of these processes runs outwards; and the other, which is the finest, runs inwards, and can be followed to the margin of the sub-epithelial connective tissue. These are the olfactory cells of Schultze. Their outer extremity bears the above-mentioned fine cilia. In man the cilia are not present. These long slender olfactory cells are in communication with the fibrils of the olfactory nerves.

The olfactory nerves come from the olfactory bulb, which is attached to a conical process of the under and front part of both sides of the brain. It is hollow, and from its external part the nerves are given off to the membrane of the nose; and from the internal surface proceeds a layer of medullary fibres, which invests the anterior surface of the contiguous portion of the brain (olfactory lobe). There is much resemblance between the bulb and the retina. It receives the brush of olfactory nerves, terminating peripherally in the olfactory cells as a short projection system, just as the retina presents a still shorter projection system—the connecting fibres between the rods and cones as terminal organs, and their nervous elements (ganglion-cells of retina) as a centre. These olfactory nerves pass off from the bulb, and extend to a *stratum glomerulosum*, consisting of nodulated masses, in and around which nucleal-like cells are distributed, imbedded in a finely granular matrix like that of the upper layer of the cortex of the brain. The next layer is Clarke's *stratum gelatinosum*; and it contains in its outer zone scattered, and in the internal zone more closely arranged nerve-cells which are partly fusiform and partly pyramidal, and are imbedded in the cortex. The next layer is medullary and granular, the granules resembling those noticed in the cerebellum. See NERVE AND NERVOUS CENTRES.

BIBL. Todd & Bowman, *Phys. Anat.* ii.; M. Schultze, *Unters. ü. d. Nasen.* 1862; Babuchin *in Stricker, Hum. & Comp. Hist.* iii. 201.

OLIGOCHÆ'TA.—An order of Annelida, comprising the earth-worm, or Lumbricidæ, and the water-worms, or Naïdidæ.

OLPID'IUM, A. Braun.—A genus of Algæ allied to *Chytridium*. Its species are epiphytes or entophytes, and affect water and land-plants.

BIBL. Archer, *Nat. Hist. Soc. Dublin*; Rabenh. *Fl. Eur. Alg.* iii. 282.

OMPHALOPEL'TA, Ehr.—A genus of fossil Diatomaceæ which agrees with *Actinoptychus*.

O. areolata (Pl. 43. fig. 53).

BIBL. Ehr. *Ber. d. Berl. Akad.* 1844, p. 263; Kütz. *Sp. Alg.* p. 132; Grev. *Mic. Trans.* 1866, p. 122.

ONCOBRY'SA, Agardh.—A genus of freshwater Algæ hitherto included in *Hydrococcus* or *Nostoc*. The species are continental.

BIBL. Rabenh. *Fl. Eur. Alg.* ii. 67.

ONCOSPHE'NIA, Ehr.—A doubtful genus of Diatomaceæ. Marine.

BIBL. Ehr. *Ber. d. Berl. Akad.* 1845, p. 72; Kütz. *Sp. Alg.* p. 11; Rabenh. *Fl. Eur. Alg.* i. 296.

ONION, *Allium Cepa* (Flowering Plants, Nat. Ord. Liliaceæ).—The young bulb of the onion offers a very good and cheap subject for the investigation of the development of spiral vessels, to those who do not object to its odour; other bulbs will do equally well. In the cells of the base of the bulb occur very elegant groups of prismatic crystals (see RAPHIDES).

ONYGE'NEI.—A family of Ascomycetous Fungi, containing a few inconspicuous plants growing upon the feathers of dead birds, or upon cast-off horseshoes. The flocculent spreading mycelium usually produces on its surface little white stalk-like bodies crowned by a globular perithecium. At first erect and thick, these supports become more slender as they elongate, and seem to bend under the weight of the light perithecium (fig. 531). In some species the perithecium is sessile. The perithecium is filled with branching filaments, arising from the walls of its internal cavity, interlacing together and bearing at their free extremities globular cells (*asci*) containing the spores (figs. 533, 535). At the epoch of

maturity the perithecium, originally closed, bursts circularly towards the base, the upper

Fig. 531.

Fig. 532.

Fig. 533.

Fig. 534.

Fig. 535.

Onygena corvina.

Fig. 531. Plants on a feather. Nat. size.
Fig. 532. Single plant with the perithecium dehiscing. Magn. 10 diams.
Fig. 533. Portion of the sporiferous layer, with asci. Magn. 350 diams.
Fig. 534. Asci detached. Magn. 700 diams.
Fig. 535. Spores. Magn. 700 diams.

part becoming detached under the form of a more or less regular cap (fig. 532), exposing the spores set free by a solution of the filaments.

British Genus.

Onyg'ena. Perithecium capitate, at length slit round the base, and falling off as an imperforate cap. Asci borne at the free ends of filaments forming an entangled mass in the perithecium, finally free and pulveraceous.

Bibl. Berk. *Brit. Flora,* ii. pt. 2. p. 322; *Ann. Nat. Hist.* vi. p. 432, 2nd ser. vii. p. 184; Tulasne, *Ann. des Sc. Nat.* 3 sér. i. p. 367, pl. 17; Greville, *Sc. Crypt. Fl.* pl. 343; Cooke, *Handb.* p. 641.

OOCAR'DIUM, Näg.—A genus of Palmellaceæ (Algæ). See Inomeria.

OOCYS'TIS, Näg.—A genus of Palmellaceæ (Algæ), probably identical with *Nephrocytium.*

Bibl. Rabenh. *Fl. Eur. Alg.* iii. 53.

OOGO'NIUM.—A term used by some Algologists to signify the parent cell of a true female spore.

OOLITE, or roestone, is the substance of oolitic rocks, and consists principally of carbonate of lime, sometimes crystallized, at others granular, and usually including organic remains, as shells, &c. It consists of two parts, one of which forms the matrix, is mostly colourless, often crystalline, and exhibits a number of rounded or oval cavities, each of which contains a nodule or mass of a corresponding form. The nodules possess rather a granular than a crystalline structure. They are sometimes coloured, hollow, and often exhibit concentric rings like those of calculi, and indicative of the successive deposition of layers. Usually a Foraminifer, some other small organism, or fragment forms the nucleus of the grain.

Polished sections of oolite form interesting objects; and where the nodules are coloured and the matrix colourless, as in oolite from Bristol, in which the former are red, the beauty of the appearance is increased.

Bibl. Works on geology (see the *Bibl.* of Chalk).

OOMY'CES, Berk. and Br.—A genus of Sphæriacei (Ascomycetous Fungi), founded on a minute plant growing upon the leaves of grasses. *O. carneo-albus* (*Sphæria carneo-alba,* Libert) has pale, flesh-coloured, tough receptacles 1-18″ high, marked with the ostioles of 3–7 perithecia closely packed within it, bearing resemblance to the eggs of some insects.

Bibl. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. vii. p. 185.

OOPHORID'IUM.—A term applied to those sporanges of Lycopodiaceæ which contain the larger or female spores.

OOSPORANGE.—A term sometimes applied to the large one-celled sacs producing zoospores in the Fucoid Algæ; also synonymous with Oophoridium.

OOSPORE.—A term used by some physiologists to indicate a spore which receives impregnation in some way before germination, as in *Œdogonium*; and also applied to the larger form of spore in Selaginella and Isoëtes.

OPAL.—A form of silica. It consists of soluble silica, and from 8 to 10 per cent. of

water. There are many varieties, thin sections of which present interesting objects for the microscope and microspectroscope. Wood opal is wood petrified with a hydrated silica, and is light and not very hard. It exhibits in some places vegetable structure. Other opals contain the remains of substances which may be of vegetable origin, or of other minerals which simulate such organisms.

BIBL. See AGATE. Dana, *Intro. Mineral.*; Slack, *M. Mic. Jn.* 1873, 105.

OPALI'NA, Purk. and Val.—All animals comprised under this title were formerly regarded as Infusoria, among which they were placed; but later researches tend to show that many are imperfectly developed forms or intermediate stages of Helminthoidea. They are microscopic, oval or oblong, colourless, covered with vibratile cilia arranged in regular rows. Some contain a nucleus, and exhibit contractile vesicles; but they do not admit colouring-matters, nor have they a mouth. In one form an adhesive suctorial disk has been observed, and in another a hook-apparatus, probably serving the same end. They are parasitic within the bodies and usually the intestinal canal of earth-worms, frogs, *Planariæ*, *Naides*, beneath the gill-plates of *Gammarus*, &c.

O. (*Bursaria*, E.) *ranarum*, P. & V., is figured in Pl. 24. fig. 47.

BIBL. Purkinje and Valentin, *De phæn. mot. vibr.*; Schultze, *Beit. z. Naturg. d. Turbell.*; Stein, *Infus.* p. 178, &c.; Claparède et Lachmann, *Etudes*, 373; Ray Lankester, *Qu. Mic. Jn.* 1870, 143.

OPEG'RAPHA, Ach.—A genus of Graphideæ (Gymnocarpous Lichens), growing on bark of trees, stones, &c. Besides their linear *lirellæ*, the fronds bear *spermogonia*, in *O. varia* and *O. calcarea* forming black spots on the surface, communicating with little unilocular cavities lined with short linear sterigmata bearing numerous spermatia. Mr. Leighton enumerates fourteen species and numerous varieties in his recent monograph.

BIBL. *Brit. Flor.* ii. pt. 1. p. 147; Leighton, *Ann. Nat. Hist.* 2nd ser. xiii. p. 87, xix. p. 129; Tulasne, *Ann. des Sc. Nat.* 3 sér. xvii. p. 207; Leighton, *Brit. Lich. Flora.*

OPERCULAREL'LA, Hincks. — A genus of Campanulidæ (Hydrozoa).

This genus was made to include *Campanularia lacerata* (Johnston).

BIBL. Johnst. *Brit. Zooph.* pl. xxviii.; Van Beneden, *Faune Litt. de Belg. poly.* 159; Allman, *Ann. Nat. Hist.* 1864, xiii. 31; Wright, *Edin. New Phil. Jn.* 1859; Hincks, *Brit. Hyd. Zooph.* 193.

OPERCULA'RIA, Goldfuss.—A doubtful genus of Vorticellina.

It is now included in *Epistylis*.

1. *O. articulata*, E. Found adherent to *Hydrophilus piceus* and *Dytiscus marginalis*. Pl. 25. fig. 25.

2. *O. berberina*, St. Found upon *Noterus crassicornis*, a water-beetle.

BIBL. Ehr. *Infus.* p. 286; Stein, *Infus.* passim; Claparède et Lachmann, *Etudes*, 111.

OPERCULI'NA, D'Orb.—A Nummuline Foraminifer. Shell flat, discoidal, many-chambered; spire exposed, and whorls rapidly increasing in width. The shell-structure of *O. arabica*, Carter, is described at p. 317 (Pl. 47. figs. 23–26). Rare in the Chalk, and abundant in many Tertiary beds. Large and plentiful in the East-Indian and South Seas; common, but small, in the northern seas.

BIBL. Williamson, *Tr. Micr. S.* ii. 159 ("*Nonionina*"); Carter, *Ann. N. H.* 2. x. 161, 3. viii. 311; Carpenter, *Phil. Tr.* 1859; *Introd. For.* 247; Parker and Jones, *Ann. N. H.* 3. viii. 229.

OPHIDOM'ONAS, Ehr.—A generic name applied to slender, filiform, spiral (helical), *Vibrio*-like bodies, of a brown or red colour, with obtuse ends, and actively moving through the water by means of an anterior flagelliform filament. Ehrenberg places them among the Infusoria, in the family Cryptomonadina, and admits two species, characterized by the difference in colour. One was found in fresh, the other in brackish water. Length about 1-570″, breadth 1-9000″. In some the spire forms only half a turn, in others two and a half turns.

Probably an Alga. Is it the young state of *Spirulina*?

BIBL. Ehr. *Infus.* p. 43, and *Ber. d. Berl. Akad.* 1840; Pritchard, *Infus.* 509.

OPHI'OCLES, Hincks. — A genus of Haleciidæ (Hydrozoa).

Char. Stem branching, rooted by a creeping stolon, hydrothecæ vase-shaped; polypites not retractile within the calycle; the body deeply constricted a little below the base of the tentacles, which surround a conical proboscis. Tentaculoid organs borne on the stem and stolon, highly extensile. Reproduction by fixed spore-sacs.

BIBL. Hincks, *Brit. Hyd. Zooph.* 230.

OPHIOCO'MA. — The Brittle-stars (Ophiurida) afford very beautiful microscopic objects; their skin-spines are especially elegant.

OPHIOCY'TIUM, Näg. — A genus of Protococcaceæ, Unicellular Algæ.

Char. Cells free, single, dispersed and floating. Obtuse or elongated, mucronate or vermiculate, and curved and mucronate. Continental.

BIBL. Rabenht. *Fl. Eur. Alg.* iii. p. 67.

OPHIOGLOSSA'CEÆ. — A family of Ferns, distinguished from all others by the characters both of the vegetative and reproductive structures. The fronds are always divided into two parts, one foliaceous and sterile, and the other fertile, neither being ever rolled up in the form of a crook. The sporanges are destitute of any trace of an annulus, and always split very regularly to discharge the spores. For an account of their germination see FERNS.

OPHIOGLOS'SUM, Linn.—The typical genus of Ophioglossaceous Ferns, represented by the Adder's-tongue Fern, *Ophioglossum vulgatum.*

OPHIOTHE'CA, Curr. — A genus of Myxogastrous Fungi, distinguished by a simple peridium bursting longitudinally; capillitium twofold, viz. hyaline articulated threads, to which the spores are attached, and echinulate thicker branched filaments.

O. chrysosperma occurs on the inner bark of dead trees.

BIBL. Curr. *Quart. Journ. Micr.* ii. p. 240; Berk. *Outl.* p. 310; Cook, *Handb.* p. 402.

OPHRYDI'NA, Ehr.—A doubtful family of Infusoria, corresponding to Vorticellina with a carapace. It forms part of this last-named family.

BIBL. Ehr. *Infus.* p. 291; Clap. et Lach. *Etudes*, 93.

OPHRYD'IUM, Ehr.—A genus of Infusoria, of the family Vorticellina.

Char. Consists of a colourless, gelatinous, rounded mass, either adherent or free, containing numerous greenish *Vorticella*-like animals imbedded and somewhat radiately arranged within it. Aquatic. Length of extended bodies 1-100''; size of entire mass from that of a pea to that of the fist, and even more.

O. versatile (Pl. 24. fig. 49, portion near the surface; fig. 48, portion expanded by pressure; fig. 50, separate animal). The gelatinous mass or envelope has been described as consisting of separate portions or cells, and again as forming a homogeneous whole. It somewhat resembles and has been mistaken for frog's spawn. The bodies of the animals, when extended, are spindle-shaped, when contracted, oval or nearly spherical; they have a row or ring of cilia at the anterior margin of the peristome, also a lid with a fringe of cilia, as in *Epistylis* &c. The body exhibits annular constrictions and longitudinal folds, and contains scattered chlorophyll-granules, and a long, narrow, tortuous nucleus. A distinct narrow elongated œsophagus is present. Ehrenberg remarks that at first the individual bodies are united in the centre by filaments, which subsequently disappear. The animals undergo the encysting process. When they leave the jelly, a posterior ring of cilia is formed, as in *Vorticella*, and the animals swim with the tail first.

This organism bears some resemblance to *Coccochloris* among the Palmellaceæ, yet it appears decidedly animal.

BIBL. Ehr. *Infus.* p. 292; Stein, *Infus.*, passim; Claparède et Lachmann, *Etudes.*

OPHRYOCERCI'NA, Ehr.—A family of Infusoria. See TRACHELINA.

OPHRYODEN'DRON, Clap. et Lach.—A genus of Acinetina.

Char. Acinetina with the suckers attached to a long retractile proboscis.

BIBL. Clap. et Lach. *Etudes*, 381.

OPHRYOGLE'NA, Ehr.—A genus of Infusoria, of the family Bursarina.

Char. Body ciliated all over; a frontal eye-spot present; cilia arranged in longitudinal rows. A watch-glass-shaped organ near the mouth.

Three species. Stein remarks that, on treating these animals with acetic acid, the cilia became converted into a dense network of curved and geniculate hairs, some as long as the body.

1. *O. atra* (Pl. 24. fig. 53). Body ovate, compressed, black, acute posteriorly; eye-spot black, marginal; cilia whitish. Aquatic; length 1-180''.

2. *O. acuminata*, brown; eye-spot red.

3. *O. flavicans*, yellowish; eye-spot red.

Lieberkühn describes in *O. flavicans* a vibrating membrane contained in a sac-like space, leading from an oral slit; and near the eye-spot a watch-glass-shaped organ; also two contractile vessels, arising close to the mouth, connected with a system of vascular canals ramifying in the outer portions of the body.

BIBL. Ehr. *Infus.* p. 360; Stein, *Infus.* p. 240; Duj. *Infus.* p. 506; Lieberkühn,

Ann. Nat. Hist. 1856. xviii. 319; Claparède et Lachmann, *Etudes*, p. 256.

OPISTHIOT'RICHA, Perty. A genus of the Infusoria.

Char. Small, elongated, cylindrical or pyriform. Cilia on body fine, those on posterior part large. *O. tenuis*, found at Bern.

BIBL. Pritchard, *Infus.* 614; Claparède et Lachmann, *Etudes*, 72.

ORBICULI'NA, Lamk.—A genus of porcellaneous Foraminifera. Discoidal, equilateral, greatly compressed, very variable according to age; forming an embracing, very regular spire when young, subsequently growing into a more or less perfect disk, almost indistinguishable from *Orbitolites*. Chambers very narrow, curved, and divided throughout their length into numerous minute cavities (chamberlets) by perpendicular partitions, transverse to the spiral coil. Orifices very numerous, round, in rows along the septal plane on the outer margin of the shell.

Living in tropical seas (*O. adunca*, Pl. 18. fig. 19); fossil in the Tertiaries.

BIBL. Carpenter, *Phil. Tr.* 1856, p. 547; *Introd. For.* 93.

ORBITOI'DES, D'Orb.—One of the hyaline Foraminifera, related to *Nummulina*, and often mistaken for it. Lenticular; thick or thin; smooth, granular, or radiate; composed of a median plane of chamberlets arranged cyclically, and of very numerous layers of compressed chamberlets above and below.

Fossil only; in the Upper Chalk, and Lower and Middle Tertiaries.

BIBL. Gümbel, *Abh. bayer. Ak.* x. 670, 1868.

ORBITOLI'NA. See PATELLINA and TINOPORUS.

ORBITOLI'TES, Lamarck (*Orbulites*).—A porcellanous Foraminifer, near *Orbiculina*, but distinguished by the chambers being arranged in concentric circles.

Inhabiting tropical seas.

O. complanatus (Pl. 18. fig. 17) = *Sorites* and *Amphisorus*, Ehr.; fossil in the Lias, Chalk, and Tertiaries.

BIBL. Morris, *Brit. Foss.* 39; Carpenter, *Phil. Trans.* 1856, 181; *Intr. For.* p. 105.

ORBULI'NA, D'Orb.—A hyaline Foraminifer, consisting either of a single spherical chamber, or of a large globular chamber enclosing a small Globigerine group of earlier cells. Orifice single, minute, round, without either prominence or rays. *O. universa* (Pl. 47. fig. 1). Recent, and fossil as far back as the Lias.

BIBL. D'Orbigny, *For. Foss. Vien.* 22; Williamson, *Rec. For.* 2; Carpenter, *Introd. For.* 176; Alcock, *Mem. Lit. Phil. Manch.* 3. iii. 178; S. Owen, *Journ. Lin. Soc. Zool.* ix. 149; Terquem, *Mém. Metz*, 1862, p. 432.

ORGANIZATION AND VASCULARIZATION.—Immediate reunion of cut surfaces may take place without any exudation; but in healing by what is termed the first intention a substance is present which glues the edges of the wound together. The microscopic investigation of this process is very interesting. The substance consists of the connective tissue of the cut surface, infiltrated with blood-corpuscles and serum, and swollen by the imbibition of the latter fluid. The next stage of the process is the migration of colourless corpuscles from the dilated vessels in the immediate neighbourhood. They permeate the whole of the cementing medium and the adjacent connective tissue, so that the divided parts are at length united by a continuous layer of embryonic tissue. The next step is the reestablishment of the circulation. Thiersch found the cut ends of the vessels a few hours after the injury, plugged by a corpuscular proliferation and somewhat dilated, but seldom occupied by a blood-clot. Injecting the vessels at this stage with a warm solution of gelatin, and hardening the specimen in alcohol, he found sticking to the surface of the club-shaped plug of gelatin, endothelial cells, some detached and isolated, others undergoing proliferation. Moreover he found a peculiar configuration of the surface of the plug, in which were the radicles of a very beautiful system of intercellular canals. He regards these as a provisional nutrient apparatus. The last act is the transformation of that part of the embryonic tissue which is not employed in the construction of vessels, into fibrous connective tissue. The spindle-shaped cell-tissue results, and from that the fibrous cicatrical textures. Should pus be formed in a wound, organization and vascularization or healing by the second intention progress (see PUS). Pus is freely given off from the wound, and from its surface young cells force their way from countless points; they are accompanied by a fluid mainly transmitted from the blood, and very rich in dissolved albuminous matters. Sooner or later the cells close up their ranks, and a layer of embryonic tissue is formed, which intervenes between the parenchyma of the organism on the one

hand and the pus on the other. Then this embryonal connective tissue gets thicker, rises into small globular projections or granulations, which are the physical bases of all further evolution; they produce both skin and cuticle, and before all, new vessels. Along certain lines running through the parenchyma in which these new vessels are to be, a closer aggregation of the cells becomes apparent; a cord or row of cells becomes visible, pointing out the form and direction of the future blood-path. Soon the blood makes its appearance in the axis of the cellular cord, and the cells parted asunder begin to constitute the wall of a new blood-vessel. As each layer of embryonal tissue is formed on the surface, rows of cells aggregate as above, and new vessels are completed. As the cicatrical tissue contracts after its formation out of the embryonal tissue, and as it is fashioned at the deepest part of the wound, first the whole of the raw surface shrinks and compresses the vessels, obliterating many and reducing the vascularity of the healing tissues.

ORIB'ATA, Latr.—This genus has been subdivided, and now constitutes the family Oribatea. The position of three species however, is doubtful, viz. *Acarus confervæ*, Schr., living in fresh water, and creeping upon Confervæ, &c.; *Oribata demersa*, Duj., aquatic, with a cervical eye, and found upon *Hypnum inundatum*; and *Oribata marina*, a marine species.

We have found one species doubtfully referable to the above, agreeing with the characters of the Oribatea: body brown, tarsi with a single claw, and no caruncle. The individuals were creeping upon broken stems of *Ceratophyllum*.

Bibl. Gervais, *Walck. Apt.* iii. p. 251; Schrank, *Ins. Austriæ*, p. 511; Dujardin, *L'Instit.* 1842, p. 316; Koch, *Deutschl. Crust.* &c.; Dugès, *Ann. des Sc. Nat.* 2 sér. ii. p. 46.

ORIBA'TEA.—A family of Arachnida, of the order Acarina.

Char. Body covered by a hard horny envelope; palpi fusiform, 5-jointed; first joint small, second large, inflated and almost half the length of the entire palpus, palpi hairy outside only; mandibles chelate; body often winged. Genera:

1. *Nothrus.* Body elongate, irregularly quadrilateral, with spinous filaments; legs of moderate length, thick.

2. *Belba.* Abdomen distinct from thorax, rounded, inflated; legs long, geniculate.

3. *Galumna.* Abdomen subglobular, depressed, margins of the pseudothorax winged; legs of moderate length.

4. *Hoplophora.* As the last, but winglike appendages absent.

Two doubtful genera: *Sillibano* and *Cæculus.*

Bibl. *Walckenaer's Aptères*, 251; Koch, *Deutschl. Crustac. &c.*; Dugès, *Ann. des Sc. Nat.* ii. 48; Dufour, *Ann. des Sc. Nat.* 1 sér. xxv. 289.

OROBIAS, D'Eichwald.—A Nummuline Foraminifer, found in the Carboniferous Limestone of Russia; possibly a true *Nummulina.*

Bibl. D'Eichwald, *Leth. Ross.* i. 352.

ORTHOCERI'NA, D'Orb.—A stichostegian Foraminifer, related to *Nodosarina*; square or triangular in cross section; without septal furrows; orifice terminal, simple or pouting.

Recent in W. Indies, *O. quadrilatera* (Pl. 18. fig. 36); fossil in the Tertiary, Chalk, Gault, and Oxford Clay.

Bibl. Carpenter, *Introd. For.* 166.

ORTHOP'TERA.—An order of Insects, containing the grasshoppers, crickets, &c.

ORTHOSI'RA, Thw. See Melosira.

ORTHOTRICHA'CEÆ.—A tribe of Pottioid Mosses including several British genera.

a. Papillæ distinct, tuberculate, rarely obsolete; peristome mostly pale, rarely orange-coloured.

1. *Zygodon.* Calyptra dimidiate. Peristome wanting, simple (external or internal), more rarely glabrous, without an annulus.

2. *Orthotrichum*, Hedw. Calyptra campanulate, plaited. Peristome absent, simple, or double. External of thirty-two geminate (sixteen) (fig. 483) or bigeminate (eight) (fig. 537) teeth, more rarely of sixteen entire, undivided teeth, granular, fleshy, or brittle, mostly pale, rarely orange-coloured, erect, afterwards reflexed, arising below the mouth of the capsule. Internal: eight or sixteen cilia, simple, hyaline, or (rarely) resembling the teeth. Vaginule ochraceous. Inflorescence monœcious or diœcious. Capsule without an annulus, more or less pyriform, grooved, rarely glabrous; operculum capitate, conical.

b. Papillæ mostly obsolete, rarely distinct; peristome always coloured, purple, red, or orange.

3. *Glyphomitrium.* Calyptra campanu-

late, large, totally enclosing the capsule, deeply laciniate, plaited. Peristome composed of sixteen short, lanceolate, densely trabeculate, entire teeth, with a central line, approximated in pairs, incurved, arising below the orifice, orange-coloured, smooth (fig. 283, p. 346). Inflorescence monœcious.

4. *Brachystelium.* Calyptra as in the preceding, altogether or almost entirely covering the capsule, mitre-shaped, with long and repeated laciniations, slightly plaited. Peristome like that of *Trichostomum,* the teeth being split more or less, down to the base, into two arms. Inflorescence monœcious.

5. *Guembelia.* Calyptra dimidiate, otherwise like the following (figs. 289–291, p. 353).

6. *Grimmia.* Calyptra mitre-shaped, laciniate, scarcely exceeding the operculum, and smooth, or else shorter. Peristome simple, teeth sixteen, lanceolate, with a median line, trabeculate, often, however, fissile, hence very polymorphous, more or less split, as far as the middle, into two or four teeth, or into two arms down to the base (fig. 288, p. 352).

ORTHOT'RICHUM, Hedwig.—A genus of Orthotrichaceæ (Pottioid Mosses), growing in round tufts, fertile at the summit, on

Fig. 536.

Fig. 537.

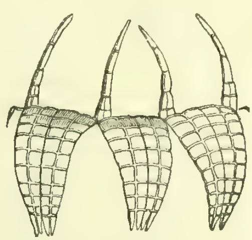


Fig. 536. Orthotrichum pulchellum. Magn. 15 diams.
Fig. 537. Orthotrichum pallens. Fragment of peristome. Magn. 50 diams.

trees and stones, never on the earth. There are numerous British species, which are remarkable for the apophyses (sometimes having stomata) and for the varied character of the outer peristome, the thirty-two teeth of which are variously conjoined, so as to appear as thirty-two, sixteen, or eight. The calyptra is mostly covered with hair-like processes (fig. 472).

BIBL. Wilson, *Bryologia Brit.* p. 185; Hooker, *Brit. Fl.* ii. pt. 1. p. 57.

OSCILLATO'RIA, Vauch., 1803 (OSCILLARIA, Bosc., 1800).—A genus of Oscillatoriaceæ (Confervoid Algæ), distinguished from the allied forms by the simple, rigid, elastic filaments, forming a stratum in a common gelatinous matrix. The filaments are enclosed singly in tubular cellulose sheaths, open at the ends, from which the fragments emerge when they are broken across (Pl. 4. fig. 8). The young filaments or growing extremities are continuous and scarcely striated; but by degrees transverse striæ appear, sometimes very close together, sometimes distant, which striæ indicate a constriction and final fission in the substance of the filament, which, when old, readily breaks at these places. The internal structure of the filament is obscure: it would seem to be composed wholly of protoplasmic substance, the joints not possessing special cellulose coats; but the substance of the filament, although apparently solid, seems sometimes less dense internally, since we have noticed a kind of hour-glass contraction intermediate between the striæ after the action of thick syrup (by endosmose) and after desiccation. The curious rounding-off of the separated ends of dividing filaments (Pl. 4. fig. 8, right-hand figures) seems to depend on some power of expansion of an outer thicker layer of the substance of the filament. The motion of the filaments has been described under OSCILLATORIACEÆ. The filaments ultimately break up at the striæ into distinct joints, which may be regarded as *gonidia.* No formation of spores has been observed. A remarkable and unexplained appearance is occasionally observed at the growing ends of the filaments: they appear crowned by a wreath of cilia; but these processes are rigid; no motion of them has ever been seen.

Kützing has multiplied the species beyond all reason, and separated some without good grounds under the name of *Phormidium.* We follow Harvey in the enumeration of the commoner British species; but this genus, like its allies, requires a thorough study of recent specimens. They occur on damp ground, on stones, on mud, in fresh water, running or stagnant, in springs, and in brackish water; a few are truly marine. In the

following characters the colour of the strata is given as seen by the naked eye, that of the filaments as seen under the microscope.

The following genera are typical; but some of them are included by Rabenhorst in PHORMIDIUM, which, as a genus, cannot be satisfactorily distinguished from the present.

* In fresh water, or on damp earth, &c.

a. Stratum æruginous or blue-green.

O. limosa, Ag. Stratum dark green, glossy, with long rays; filaments green, 1-3300 to 1-3600″ in diameter; articulations shorter than the diameter. At the bottom of ditches and pools.

O. tenuis, Ag. Stratum dark green, thin, with short rays; filaments pale green, 1-4200″ in diameter; articulations equalling or half the diameter. In muddy ditches, &c.; at first on the bottom, finally floating to the top.

O. muscorum, Ag. Stratum dark æruginous-green, 3 or 4″ in extent, growing over mosses in rapid streams; filaments 'thickish,' pale blue-green.

O. turfosa, Carm. Stratum pale verdigris-green, glaucous, 1 or 1½′ in diameter, resting on an ochraceous substratum; filaments hyaline, "very slender." On floating sods in turf-pits.

O. decorticans, Grev. Stratum smooth, glaucous-green, membranous, peeling off in flakes; filaments pale bluish green, "very slender." Damp walls, pumps, &c.; common.

b. Stratum dull green, inclining to purple, black, or brown.

O. nigra, Vauch. Stratum blackish green (bluish black when dry), with long radii; filaments pale bluish green, 1-2800 to 1-3000″ in diameter; joints equalling or a little shorter than the diameter. Ditches and ponds. Common.

O. autumnalis, Ag. (Pl. 4. fig. 8). Stratum purplish or greenish black; filaments pale dirty bluish green, 1-4000 to 1-5000″ in diameter; joints shorter than the diameter. Damp ground, walls, &c. Common.

O. contexta, Carm. Stratum glossy black, spreading three feet or more, appearing satiny and striated to the naked eye; filaments pale green, 1-3000″ in diameter; articulations largish. On mud; apparently common.

O. ochracea, Grev. is probably the same as *Leptothrix ochracea*.

** Marine, or in brackish water.

O. littoralis, Carm. Stratum bright æruginous-green; filaments deep green "thicker than in *O. nigra*;" joints one third the diameter. Pools on the sea-shore. See SYMPLOCA.

BIBL. Harvey, *Brit. Alg.* 1st ed. p. 161; *Br. Mar. Alg.* p. 228; *Phyc. Brit.* pls. 105, 251; Hassall, *Br. Fr. Alg.* p. 244, pls. 70–72; Kütz. *Sp. Alg.* p. 237; *Tab. Phyc.* Bd. i. pls. 38–44; Rabenht. *Fl. Eur. Alg.* ii. 95.

OSCILLATORIA'CEÆ.—A family of Confervoid Algæ, containing organisms of considerable diversity and not very well characterized at present, owing to the obscurity of the reproduction. The genus *Oscillatoria*, with its nearest allies, is composed of cylindrical filaments of protoplasmic substance, invested by a continuous cellulose sheath or tubular cell-membrane. The internal (solid?) filament gradually becomes transversely striated as it increases in age, and subsequently readily breaks across at the transverse lines; and the fragments readily escape from the sheaths, since no cross walls of cellulose are produced (Pl. 4. fig. 8). These kinds exhibit clearly the remarkable motion from which the family takes its name. They are mostly found upon damp ground, forming wide and irregular strata. *Rivularia* and the allied genera have the joints of the filaments more distinct; and the filaments are coherent into definite fronds, on which they stand erect or radiate from a centre (Pl. 4. figs. 13, 16). The sheaths become complicated in many of these, from the internal multiplication and the persistence of the cellulose sheaths of several generations one within another (see PETALONEMA), often gelatinously swollen up, and sometimes decomposed into spiral fibrous structures (Pl. 4. fig. 15; see SPIRAL STRUCTURES). Some of the remaining forms, included here for the present, differ considerably from the above, and are imperfectly understood. *Vibrio* (Pl. 3. figs. 18–21) consists of moniliform filaments without an apparent sheath. *Spirulina* (Pl. 3. fig. 15) has the (solid?) filaments curled spirally; and in the strange plant *Didymohelix* (Pl. 1. fig. 10) two spiral filaments occurred twined together. These last minute forms generally occur imbedded in a gelatinous stratum; but their relation to this is not yet clearly ascertained.

The structure of the Oscillatoriaceæ, judging from *Oscillatoria*, *Microcoleus*, and *Lyngbya*, differs importantly from that of all other Confervoids. The filaments are

not composed of rows of cells, but, in the earliest condition, of a cylindrical thread of protoplasm, coloured greyish, green, brown, or purple in different cases. The ends of growing filaments are narrower and devoid of striæ, and have no perceptible cellulose sheath; when a little older, cross striæ appear, consisting of double rows of granules or dots, and the tubular cellulose coat is evident; finally the striæ become distinct lines (see Pl. 4. figs. 8–22). In this stage, external violence will cause the filament to break across at the striæ; and the fragments then slide along inside the cellulose sheath, the broken ends always assuming a rounded form like that of the free extremities (Pl. 4. fig. 8 *b*). When these fragments slide quite out of the sheaths, the latter appear as continuous tubes (Pl. 4. fig. 8 *a*), seldom with any cross markings opposite the striæ of the internal mass. In *Lyngbya* the division seems to take place in a peculiar manner, accompanied by an interstitial growth comparable to that of ZYGNEMA. In a well-developed filament, every eighth stria is strongest, the intermediate fourths rather lighter, every second one between them paler still, and the intermediates of these only just marked; while in *Oscillatoria* the striæ seem to be gradually less definite towards the growing apex of a filament. The filaments appear solid as ordinarily viewed; but the endosmose resulting from placing them in syrup or gum-water causes them to contract between the striæ, or to break up into lenticular disks. The ultimate fate of all the filaments seems to be a separation into disks or globular gonidia, by breaking across at the striæ.

In *Microcoleus* (Pl. 4. fig. 9) and many *Rivulariæ* there would appear to be a transverse multiplication like that occurring occasionally in NOSTOC, as the filaments are found lying side by side in gelatinously decomposed outer (parent) sheaths. The filaments of the *Rivulariæ* are seated on a large basal cell (Pl. 4. figs. 13, 16, 18), the nature of which is not understood.

The remarkable spontaneous motion of many Oscillatoriaceæ presents a considerable variety of conditions. In *Oscillatoria* and *Microcoleus* the ends of the filaments emerge from their sheaths, the young extremities being apparently devoid of this coat; their ends wave backwards and forwards, somewhat as the fore part of the bodies of certain caterpillars are waved when they stand on their pro-legs with the head reared up. The filaments also emerge from the tubes and break up; and the fragments then exhibit an oscillating movement like that of a balance, together with an advance in a longitudinal direction. *Lyngbya* (Pl. 4. fig. 10) does not appear to oscillate, at all events when in long filaments. *Vibrio*, *Spirulina*, and other forms exhibit only a tremulous oscillation; the same appears to be the case with *Bacterium*; the plant termed *Didymohelix* probably acquires its double-spiral character from the entwining of originally distinct filaments. These last organisms were included by Ehrenberg among the Infusoria; but there is every reason to regard them as vegetables. *Leptothrix* and the allied genera are very imperfectly known, and are only included here from the absence of indications of closer affinities elsewhere; very likely they are mycelial filaments of Fungi.

All these plants occur on damp ground, rocks, or stones, and among Mosses and other Confervæ on rocks, stones, &c. in fresh and salt water, and are allied in some respects to the NOSTOCHACEÆ; but the articulations of the filaments of the latter are all perfect cells with a complete cellulose wall, multiplying by division in the same way as the Confervaceæ.

Synopsis of British Genera.

A. *Oscillatorieæ.* Filaments transversely striated or moniliform, sometimes spirally curled; sheathed, or, in the minute forms, without evident sheaths; exhibiting spontaneous oscillating, creeping, or serpentine motion. Increased by transverse division.

1. *Bacterium* (Pl. 3. fig. 17). Filaments colourless, extremely small, short, wand-shaped, or longish-oval, with two to four cross striæ, exhibiting a vibratory motion. No sheaths evident.

2. *Vibrio* (Pl. 3. figs. 18–20). Filaments colourless, extremely slender, moniliform, with an active serpentine motion. No sheath evident.

3. *Spirulina* (Pl. 3. figs. 15, 22, 23). Filaments green, very slender, continuous or moniliform, curled into a long helical or screw-like form; oscillating; no sheaths evident, but often a common investing jelly.

4. *Didymohelix* (Pl. 1. fig. 10). Filaments brown, very slender, continuous, curled spirally and twisted together in pairs.

Motion?. No evident sheaths, but a common investing jelly.

5. *Oscillatoria* (Pl. 4. fig. 8). Filaments coloured, continuous, transversely striated, readily breaking across, with a proper cellulose sheath, oscillating; collected in strata and imbedded in a common gelatinous matrix.

6. *Microcoleus* (Pl. 4. fig. 9). Filaments as in *Oscillatoria*, but collected in bundles in a common gelatinous tubular sheath, which is dichotomously branched; filaments oscillating.

7. *Cœnocoleus.* Flaments branched, contained with their ramifications within a tough, more or less permanent sheath which bursts irregularly. Filaments annulated.

8. *Symploca.* Filaments as in *Oscillatoria*, but erect and tufted, coherent at their bases, bristling above.

B. *Lyngbyeæ.* Filaments motionless (?), oscillarioid, enclosed in a very distinct sheath, tufted, or forming strata, with or without an enveloping jelly.

9. *Dasyglœa* (Pl. 4. fig. 11). Filaments unbranched, sheathed; older sheaths broad, coalescent outside into an amorphous gelatinous stratum.

10. *Lyngbya* (Pl. 4. fig. 10). Filaments elongated, distinctly articulated, unbranched, with distinct convoluted cellulose tube, but without a gelatinous matrix (motion creeping?); articulations very close.

11. *Leibleinia.* Filaments short, erect, tufted, unbranched, with distinct cellulose coat, free, without an investing jelly.

C. *Scytonemeæ.* Filaments distinctly articulated, simple or branched, motionless, with distinct articulations and large interstitial (propagative?) cells; sheaths at length softened and swollen, but without a common gelatinous matrix.

12. *Scytonema* (Pl. 4. fig. 19). Filaments cæspitose, or more rarely fasciculate, with a double (lamellar) gelatinous sheath, (mostly) closed at the apex; branches continuous by lateral growing out of the primary filaments, with a knee-like base.

13. *Desmonema.* Filaments branched, more or less coherent, branches of two kinds, primary branches each with a connecting cell at the base, secondary branches without connecting cells; annulated. See Tolypothrix.

14. *Arthronema* (Pl. 4. fig. 20). Filaments distinctly articulated, simple, in short lengths, overlapping at their ends within the gelatinous sheath.

15. *Petalonema* (Pl. 4. fig. 21). Filaments branched, with the outer sheaths of the single joints expanded upwards and outwards into funnel-shaped bodies, each partly overlapping its successor, forming a common obliquely lamellated and transversely barred gelatinous cylinder.

16. *Calothrix* (Pl. 4. fig. 22). Filaments very closely articulated, tufted, with branches in apposition for some distance, here and there cohering laterally. Sheaths firm, often dark-coloured.

17. *Tolypothrix.* Filaments free, radiantly or fastigiately branched, most distinctly articulated at the bases of the branches; branches continuously excurrent, not in apposition; sheaths thin, hyaline.

18. *Sirosiphon.* Filaments single, double or triple, within a distinct common sheath, very distinctly articulated; branched by lateral budding, the branches divergent.

19. *Schizothrix* (Pl. 4. fig. 17). Filaments branched by division; sheaths lamellated, thick, rigid, curled, thickened below, finally longitudinally divided.

20. *Symphyosiphon.* Filaments erect or ascending, enclosed in lamellated, hard sheaths, concreted laterally at their bases, involved in jelly.

21. *Rhizonema.* Sheath cellular and furnished throughout its length with numerous branched and anastomosing rootlets (?). Filaments distinctly annulated, and interrupted here and there by a connecting cell. Branches in pairs, arising from a protrusion of the filament.

D. *Rivularieæ.* Filaments distinctly articulated, with an enlarged basal cell, mostly attenuated above, connected into definite or indefinite fronds; motionless.

22. *Schizosiphon* (Pl. 4. fig. 13). Basal cells globose, filaments simple, distinctly articulated, mostly attenuated towards the apex, sheathed, sheaths connate into groups, hard, dark-coloured, open and expanded above, and overlapping so as to form a succession of ochreæ which have the free borders slit up into filaments or fringes; also displaying a spiral fibrous structure in dissolution.

23. *Physactis.* Filaments whip-shaped, torulose at the base, sheathed, sheaths simple, gelatinous; collected into a globose and solid, or subsequently a bullose-vesicular frond; in the globose fronds the fila-

ments radiate from the centre, in the vesicular fronds from the internal (lower) surface of the gelatinous matrix.

24. *Ainactis* (Pl. 4. fig. 15). Filaments branched, articulated, with thin sheaths, collected into a solid pulvinate frond, which is concentrically zoned by the dichotomous branching of the filaments. Sheaths more or less solidified by carbonate of lime; sometimes exhibiting a spiral structure in dissolution.

25. *Rivularia* (Pl. 4. fig. 18). Filaments with an oval basal cell succeeded by one of cylindrical form (*manubrium*), the remainder short, attenuated in diameter upwards (whip-shaped). Sheaths sometimes saccate below, open (not fringed) above; forming a slippery gelatinous frond.

26. *Euactis* (Pl. 4. fig. 16). Filaments whip-shaped, with repeated ochreate sheaths, forming fronds in which they radiate, and by superposition of successive generations form concentric layers. The ochreate sheaths are cartilaginous, lamellated, firmly united laterally, dilated upwards (funnel-shaped), decomposed into a fringe at the open edge.

27. *Inomeria.* Filaments whip-shaped, vertical, parallel, with obscure sheaths, everywhere decomposed into very slender filaments; forming crustaceous fronds, becoming stony.

28. *Petronema.* Densely cæspitose, erect, somewhat regularly branched, branches free, with obtuse rounded apices, and each with a connecting cell at the base. Filaments annulated and growing thicker upwards.

E. *Leptotricheæ.* Doubtful Oscillatoriaceæ.

29. *Leptothrix.* Filaments very slender, neither branched, articulated, concreted, nor sheathed.

30. *Hypheothrix.* Filaments unbranched, inarticulate, sheathed, interwoven into a more or less compact stratum.

31. *Symploca.* Filaments unbranched, inarticulate, sheathed, concreted into branches, conjoined at their bases; sheath a simple hyaline membrane.

Excluded Genera.

Stigonema, Ag. See Ephebe.—*Arthrosiphon*, Ktz. = *Petalonema.*—*Chthonoblastus*, Ktz. = *Microcoleus.* — *Hassallia*, Berk. = *Sirosiphon.*—*Lithonema*, Hass. = *Ainactis.*—*Phormidium*, Ktz. = *Oscillatoria.*—*Symphyothrix*, Ktz. = *Oscillatoria.*—*Spirochæta*, Ehr. = *Spirulina.* — *Spirillum*, Ehr. = *Spirulina* and also Spermatozoids of Mosses and Characeæ.—*Spirodiscus*, Ehr.?

Bibl. See the genera, especially Oscillatoria and Rivularia, and Spiral structures; Rabenh. *Fl. Eur. Alg.* ii.

OSMUN'DA, Linn.—A genus of Osmundeæous Ferns, represented in Britain by *Osmunda regalis* (figs. 222, 223, p. 307), the 'Royal or Flowering Fern,' as it is termed, a large and handsome plant, found in damp situations; not common.

OSMUN'DEÆ.—A tribe of Polypodiaceous ferns, characterized by the broad imperfect annulus on the back of the sporanges.

Genera.

1. *Osmunda.* Sporangia borne on metamorphosed pinnules.

2. *Todea.* Sporangia placed on unchanged pinnules.

OSTRACO'DA. See Entomostraca.

OTOGLE'NA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes three; one sessile and cervical, the two others stalked and frontal.

Neither jaws nor teeth present.

O. papillosa. Body campanulate, turgid, rough with papillæ; aquatic; length 1-96".

Bibl. Ehr. *Infus.* p. 453; Pritchard, *Infus.* 690.

O'TOLITHS.—Calcareous particles and bodies connected with the organ of hearing in many animals.

The otoliths contained in the membranous labyrinth of the ear present many variations in different animals in regard to their consistence, size, and form. They adhere tolerably firmly together by means of a clear tenacious substance. In Reptiles and osseous Fishes the delicately formed otoliths attain a considerable size, whilst in Birds, Mammals, and Man they either appear to be amorphous or are crystallized in the form of small rhombs, hexahedra, or octahedra. Otoliths of various sizes and forms may, however, be found in the same animal. Three or four otolithes of exceedingly pretty form occur in the osseous Fishes, where they are found both in the sacculi and in the ampullæ. In Man and Mammals they form the white spots of the maculæ acousticæ; and both here and in other animals they are maintained in position by a tenacious gelatinous substance, which Lang has described in the Cyprinoids as a peculiar fenestrated membrane (but which is regarded by Kölliker as a cuticular formation). Deiters and Hasse admit the

presence of a fenestrated cuticular formation on the inner surface of the columnar epithelial cells in the otolithic sac of the Frog, by means of which its contact with the otoliths is prevented.

Otoliths are essentially composed of carbonate of lime; according to Henle, however, after treatment with acids there is a residue which is composed of organic substances (otolith cartilage). Leydig has observed in the otolith of the grouse that, after treatment with bichromate of potash, peculiar lines occur at the two poles, which converge towards the centre. In Man and Birds, even when the vestibule is quite uninjured, otoliths may be observed in considerable numbers in the membranous semicircular canals, especially in the horizontal one, and according to Hyrtl in the fluid of the cochlea. In these cases it is impossible to admit that they have escaped into the semicircular canal from the utriculus.

The Crustacea, which possess an auditory sac, have particles of siliceous sand in it which probably act as otoliths. In the Gasteropoda there are auditory vesicles or otocysts in the form of minute sacculi, containing fluid wherein are suspended a number of minute calcareous particles—otoliths. The cilia lining the vesicles keep them in constant movement. By crushing the head of a young Gasteropod under the thin glass of a slide, the sacculi can usually be seen. The resemblance of some otoliths, especially those of fishes, to the so-called coalesced lime-cells of Rainey is very remarkable.

BIBL. Weldeyer and Rüdinger, *in Strick. Man. Hum. & Comp. Hist.*; Carpenter, *The Microscope*; Todd and Bowman, *Physiol.*; Lacaze-Duthiers, *Archiv. de Zool.* parts i. & ii.; Leydig, *Schultze's Archiv*, quoted in *Qu. Mic. Jn.* 1871, p. 421.

OTOSTOMA, Carter.—A genus of Oxytrichina (Infusoria).

Char. Body ovoid, mouth ear-shaped; anus terminal; nucleus long; contracting vesicles double. Its cysts have been discovered on *Nitella*, and give exit to monadiform beings approaching the parent shape.

BIBL. Carter, *Ann. Nat. Hist.* 1856, xvii. 117; Pritchard, *Infus.* 639.

OVA OF ANIMALS.—The germs secreted by the ovaries. When extruded from the body, they are generally termed eggs (EGGS). See OVUM.

OVARY.—The organ in which the ova or germs of the future offspring are formed and temporarily contained.

The ovary consists of an outer fibrous coat, and a parenchyma or stroma, which includes the Graafian follicles.

The outer coat, or tunica albuginea, is firm, white, and intimately connected with the subjacent stroma; it consists of three or more laminæ of connective tissue composed of short and dense fibres with a few fusiform cells. In early life this coat is inseparable from the stroma, and is very thin.

In the Mammalia, the stroma (fig. 538 *e*) consists mainly of pure connective tissue, and may be divided into two parts—one external and parenchymatous or cortical, and the other a highly vascular medullary substance. A layer of epithelium covers the so-called tunica albuginea, and is columnar and darkly granular, being therefore different from that of the peritoneum, into which it passes at the base of the organ. It is continuous with that of the Fallopian tube or oviduct. Beneath this

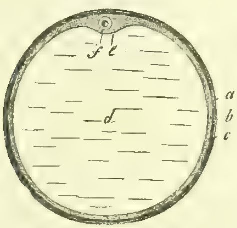
Fig. 538.

Transverse section of a human ovary at the fifth month of pregnancy. *a*, Graafian vesicle of the under, *b*, of the upper surface; *c*, peritoneum; *d*, the tunica albuginea; in the centre are two corpora lutea; *e*, stroma of the ovary.

germ-epithelium, which is here and there found to line tube-like inward prolongations of the ovarian surface (the ovarian tubes), is the connective tissue of the tunica; and indistinctly visible beneath these layers are Graafian follicles of various sizes. They usually project slightly, and are surrounded by a plexus of vessels perceptible to the naked eye. Between them "corpora lutea" may be seen, which are ovisacs in a condition of atrophy or retrogression. Amongst the superficial structures are the connective-tissue fibres of the parenchymatous or cortical substance; and these surround a few ovarial tubes and young ovi-

sacs or follicles. Deeper down are more mature follicles, some of which contain nearly ripe ova; and then comes the vascular or medullary substance. Smooth muscular fibres lie in detached longitudinal fasciculi, surrounding the larger and medium-sized arteries (which they sometimes invest like a sheath) of the vascular substance, and they may be followed as far as the cortical layer. The vascularity of the ovary is very great; and the hilus contains a convoluted mass of large veins, which, when strongly injected, form a kind of vascular bulb. The arteries pursue a corkscrew course; and intensely vascular plexuses exist in relation with the follicles. Usually layers of extremely small follicles are arranged in grape-like groups immediately beneath the tunica albuginea; and the Graafian follicles abound in the structure immediately beneath, which is eminently cellular in the Mammalia. The follicles or vesicles vary greatly in number and size; the largest are generally nearest the surface, and project more or less, so as to give it a nodular aspect. They are round closed sacs (fig. 539). Each

Fig. 539.



Graafian vesicle of the pig. *a*, outer, *b*, inner layer of the fibrous coat; *c*, membrana granulosa; *d*, liquid contained in the vesicle; *e*, proligerous disk; *f*, ovum with the zona pellucida, yolk, and germinal vesicle.

Magnified 10 diameters.

possesses two coats; the outer is a fibrous and vascular layer, connected with the stroma by somewhat lax areolar tissue, which consists of two layers: the outer is composed of ordinary fibrous connective tissue; and the inner or tunica propria consists of young connective tissue, rich in cells, which are usually fusiform, stellate, or spheroidal, and resemble amœboid cells. Injected vermilion gets from the vessels into these cells. Lining this is the epithelium of the follicle, which covers the whole of the inside of the tunica propria, and forms the *membrana granulosa* (fig. 539 *c*); but there is a doubt whether a basement membrane intervenes. The epithelium is stratified and columnar, and is collected in various-sized masses (the discus proligerus) at one or more points; and the free surface of the cells is in contact with the fluid of the follicle.

The columnar cells of the epithelium appear to be entirely destitute of an investing membrane; their nucleus is elliptical, transparent, colourless, and centrally situated, and when arranged in the above mentioned groups they come into contact with the layer of columnar cells which surround the ova. The ovum thus lies imbedded in the epithelium of the Graafian follicle, and is nourished by the vascular plexus of the tunica propria.

The cavity of the Graafian vesicle contains a liquid resembling the serum of the blood; and in it are found granules, nuclei, and cells, arising from the disintegration of the membrana granulosa.

When the vesicle bursts or is opened, the ovum escapes surrounded by the cells of the proligerous disk and the adjacent part of the epithelium.

In those animals in which the amount of stroma present is small in proportion to the size of the vesicles, the ovaries have a racemose appearance.

In many of the lower animals the ovaries are tubular, the ova lying closely packed within them.

In the Infusoria, the "nucleus" (see Infusoria) is the ovary, and the germs are produced therein; and in the Actinia and stony Corals the ova are developed in the fringes of the so-called mesenteries. In the Echinodermata the ovaries are composed of rounded or elongated tubes that are usually united together into several gland-like groups, corresponding in their number and arrangement with the radial segments of the body; and in the Holothuridæ the small gland-tubes open into one or more excretory ducts. The Polyzoa have the ovaries attached to the upper part of the cell. In Vermes the true ovary is either a vesicular organ opening by a special excretory duct into the complicated sexual canal, or, as in the Ascaridæ, it constitutes the ultimate cæcal extremity of the genital tube. Special glands or yolk-stocks are present in the Cestodes and Trematodes. The Mollusca have well-developed glandular organs for the formation of ova, consisting of numerous acinous follicles. A

peculiar gland imbedded usually in the substance of the liver, and in which both ova and seminal corpuscles are found, is widely distributed through this class. In the Arthropoda, structures exist which precisely correspond to the Graafian follicles, and the double tube-like ovaries of insects; and their ducts open into a dilated receptaculum seminis (Pl. 27. fig. 19). The ovarium of the spider usually presents the form of a long fusiform body, which opens into a slender oviduct terminating, with its fellow of the opposite side, in a transverse vulva situated between the pulmonary stigmata. In *Epeira* there is a septum in the ovarium. The scorpion has ovaria which are expanded into sacs below, and bulged out into slender, cæcal, short tubes above; the sacs enter the ducts at right angles. The female organs of the Crustacea become more complicated as the species ascend in the class. In most of the Entomostraca the impregnated ova are carried in ovisacs; and in *Limulus* the ovarian mass interblends its lobes and processes with those of the liver. In the lobster the ovaria are of great length on each side, and the oviduct comes off from the outer part of nearly the middle of the gland, and descends to terminate at the basal joint of the third pair of ambulatory feet. In the *Brachyura* there are on each side an ovary, oviduct, and pouch; and the ovaria in many are elongated pouches divided in the midst, where the oviduct is attached. In the Dibranchiate Cephalopoda, as in the *Nautilus*, there are an ovarium, oviduct, and some glands. The ovary is single, and the ovisacs are elliptical and have reticulated walls. There is a single oviduct, with a glandular laminated outlet, in the cuttle-fish. In the Octopoda there are two oviducts, and sometimes an additional glandular enlargement on them.

BIBL. Kölliker, *Mikr. Anat.* ii.; Siebold, *Vergl. Anat.*; Todd's *Cyclop. Anat.*; Owen, *Lectures*, i.; Waldeyer, *in Stricker's Hum. & Comp. Hist.*

OVIPOS'ITOR.—An appendage of the abdomen in certain insects for the deposition of eggs. The simplest form is that of a tube of greater or less length, which is enclosed in a cleft sheath. The Ichneumons and the Grasshoppers possess such organs. But when the insect has to perforate tough animal or vegetable structures, and then to lay eggs, the extremity of the organ has a serrate edge. The ovipositors of the Saw-flies and Siricidæ are beautiful objects for the microscope. Their saws are modifications of the sting; they are broader, are toothed for a greater length, and are made to slide along a firm piece that supports each blade. They are worked alternately with rapidity, and finally are separated whilst the egg is passed between them, followed sometimes by a mucous secretion, which dries rapidly. Some Diptera, the Gad-fly for instance, have jointed ovipositors, in order that perforation may come through thick integuments.

BIBL. Carpenter, *Microscope*, and *Bibl.* therein, p. 683.

OV'ULE or OV'ULUM.—The name applied to the rudiment of the seed of Flowering Plants, produced in the ovary or germen during the development of the flower, fertilized by the pollen-grains when complete, and afterwards converted into a SEED by the development of the EMBRYO and other secondary structures during the conversion of the ovary into the fruit. For the general conditions of the ovules in ovaries, reference must be made to botanical works. The ovules make their appearance upon the placenta as cellular papillæ rising up from its surface, and at first are simple; this first development, the main feature of the organ, is called the *nucleus* (figs. 540–542). In rare cases this remains naked; but in most instances one or two coats are produced, arising as circular folds near the base, and gradually growing up over the nucleus (fig. 542), leaving only a small passage at the apex, leading down to the point of the nucleus. When two coats are formed (fig. 543), the inner appears first; the outer originates later and grows up over the inner, and it is generally thicker and more developed. The inner is called the *secundine* by

Fig. 540.

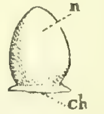


Fig. 541.

Atropous ovules.

Fig. 540. Young ovule of Chelidonium. *n*, nucleus; *ch*, chalaza.
Fig. 541. Young ovule of mistletoe, consisting of a nucleus only.

Mirbel, the outer the *primine* (figs. 543, 544, 547 *S, P*). The German writers reverse

Fig. 542.

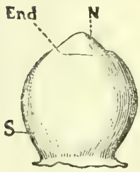
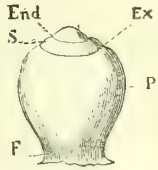


Fig. 543.



Atropous ovules.

Fig. 542. Young ovule of walnut, consisting of a nucleus *N*, with a single coat *S*; *End* the endostome or micropyle.

Fig. 543. Young ovule of Polygonum. *F*, funiculus; *P*, primine (of Mirbel); *S*, secundine; *Ex*, exostome; *End*, endostome.

Magnified 40 diameters.

these names, resting on the true order of development. Some term them the *integumentum internum* and *externum*. The inner is the *tegmen*, the outer the *testa* of R. Brown. The passage at the apex, leading to the nucleus, is called the *micropyle*; sometimes the orifice in the outer coat is distinguished from that in the inner coat, and they are termed respectively *exostome* and *endostome* (fig. 547). While the nucleus and coats are becoming perfected, one of the cells situated near the apex of the nucleus takes

Fig. 544.

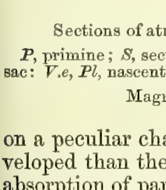
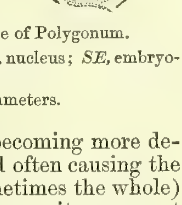


Fig. 545.



Sections of atropous ovule of Polygonum.

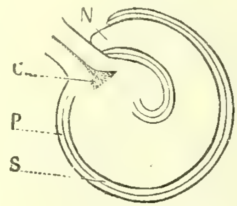
P, primine; *S*, secundine; *N*, nucleus; *SE*, embryo-sac: *V.e*, *Pl*, nascent embryo.

Magnified 20 diameters.

on a peculiar character, becoming more developed than the rest, and often causing the absorption of part (or sometimes the whole) of the tissue of the nucleus; it appears at length as a large sac occupying the centre of the ovule; this is the *embryo-sac* (fig. 544). The base of the ovule is pushed up from the surface of the placenta during its development so as to appear at length supported on a stalk of variable length; this is termed the *funiculus* (figs. 543 *F*, 547 *f*); the point of attachment of this stalk to the body of the ovule (marked by a scar when the ripe seed separates) is called the *hilum*. That region of the interior where the lower parts of the coat are confluent with the base of the nucleus, is called the *chalaza* (fig. 546 *C*).

The form of ovules is much affected by excessive development of its constituent parts in special directions before the fertili-

Fig. 546.



Section of campylotropous ovule of the wallflower.

C, chalaza; *N*, nucleus; *S*, inner coat; *P*, outer coat.

Magnified 20 diameters.

zation. If all parts grow equally, the complete ovule is erect on the placenta, with its hilum and also the chalaza turned towards the latter, and its micropyle at the opposite free end; such an ovule is technically termed *atropous* or *orthotropous* (figs. 541–545). Very frequently an excessive growth takes place at one side of the coats of the ovule, so that the chalaza is carried up and directed away from the placenta, the micropyle being at the same time turned down towards the latter; but as the growth is in the coats of the ovule, the hilum remains at the base, near where the micropyle arrives; such an ovule is termed *anatropous* (fig. 116, p. 151). The hilum is then connected with the chalaza by a ridge (a kind of adherent funiculus) called the *raphe*. In other cases the form becomes altered by the point of the ovule turning down, and the entire structure becoming folded or bent upon itself, without disturbance of the relative positions of the hilum and chalaza, while the micropyle is brought down, as in the anatropous ovule, to the vicinity of the hilum. This form is termed *campylotropous* (fig. 546). Other conditions occur less frequently, among which is the *amphitropous* form (figs. 550 & 551).

During these developments the embryo-sac also undergoes various changes. Some-

times, as in the Orchidaceæ, it expands so as to obliterate all the tissue of the nucleus, and appears like a simple sac enclosed by

Fig. 547.

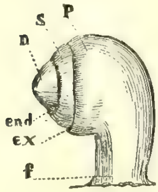


Fig. 548.

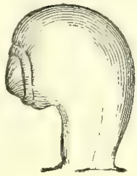
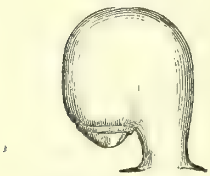


Fig. 549.



Magnified 40 diameters.

Fig. 550.

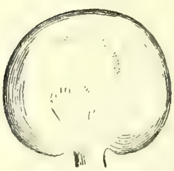
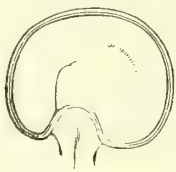


Fig. 551.



Magnified 20 diameters.
Amphitropous ovule of Mallow in different stages.
Fig. 551. Section.

the coats; in the Scrophulariaceæ and other orders it produces peculiar lobes or pouches at various points; in the Santalaceæ it grows out from the summit of the nucleus as a free, naked, tubular process, &c.

Up to this point the differences in ovules are such as may be termed secondary; but a primary distinction now comes into view, connected also with a difference in the external conditions, affording grounds for the division of the Flowering Plants into two great classes. In the Coniferæ and Cycadaceæ the ovules are developed upon open carpels, and consequently the micropyle may receive the pollen-grains immediately, when expelled from the anthers. Plants exhibiting this condition are termed Gymnosperms, or naked-seeded. In the Dicotyledons and Monocotyledons the carpels are always closed up into cases or ovaries, surmounted by a *stigma*, sessile or elevated upon a style, and the pollen, falling upon the stigma, produces there its pollen-tubes, which pass down through what is called the conducting tissue of the style and upper part of the ovary, on to the placentæ, whence they make their way to the micropyles of the ovules. Plants exhibiting these conditions are distinguished as Angiosperms or covered-seeded.

The next phenomena which characterize the development of the ovules of the Angiosperms may be briefly given as follows. The formation of the embryo-sac has already been described. Shortly before the opening of the flower, in most cases, this sac is more or less densely filled with granular protoplasm, in which a variable number of nuclei may be seen (Pl. 38. figs. 1–7). About the time when the pollen-grains are discharged from the anthers, a number of minute, free, globular protoplasmic bodies may be discovered in the embryo-sac, usually three (more rarely one) of these being crowded into the upper end of the embryo-sac and constituting what are called the *germinal bodies* or *masses* (Pl. 38. fig. 4). Others, which often occur in the embryo-sac, are generally collected near the bottom of it; they are apparently characteristic of particular families only; in some plants they are very large, as in the *Crocus*. About this time the embryo-sac often exhibits asymmetrical growth, forming pouches or processes, sometimes at the summit, sometimes at the base.

When the pollen-grains fall upon the stigma, they produce their pollen-tubes (see Pollen), which pass down through the conducting tissue, and enter the micropyles of the ovules. When they reach the apex of the embryo-sac, they either stop, often swelling a little, or they pass down a short way over its side (Pl. 38. fig. 5). Very unfrequently two pollen-tubes are found engaged in the micropyle of the same ovule. It is not absolutely known whether the cavities of the pollen-tube and the embryo-sac become actually continuous by absorption of the walls at the point of attachment: it is generally believed not; but we have had occasion to feel some doubt on this point. The essential point of the process is the intermixture of the contents of the pollen-tube with the substance of the germinal body. In the higher Cryptogamia

and in the Algæ, the impregnation is of a similar nature; but there the germ-masses are fertilized by the agency of spermatozoids, which make their way to them, either *constituting* or *carrying* the impregnating matter, which in the case of the pollen-tube is a liquid, containing fine granules, but exhibiting no trace of active spermatic bodies, except that refractive granules are sometimes seen in active motion in the end of the pollen-tube.

Soon after the pollen-tube has reached the point of the embryo-sac, one (rarely two, giving rise to POLYEMBRYONY) of the germinal bodies becomes invested by a cellulose membrane (*germ-cell*), and usually changes from a spherical to an oval form, a transverse septum soon dividing it into two. Most frequently the elongation continues, with a successive formation of septa, until the nascent embryo appears as a rounded or oval cellule suspended at the base of a simple confervoid filament (*suspensor*); in other cases the formation of the first transverse septum is followed by the expansion into two globular cellules connected by a narrow neck, the upper, almost devoid of contents, constituting the suspensor (*Potamogeton*, *Zannichellia*); in *Orchis*, the upper of the first two cells grows upwards and outwards, as a blind septate confervoid filament, through and beyond the micropyle of the ovule. In *Tropæolum* and *Zea*, the suspensor becomes more complex, by formation of perpendicular septa. In all cases the end-cell (*embryonal cell*), at the point of the suspensor, which always appears densely filled with protoplasm, ultimately enlarges, and by segmentation is converted into the *embryo* (Pl. 38. fig. 6).

During the early development of the embryo, the embryo-sac is often found more or less densely filled with free cells formed from its protoplasm (*endosperm*-cells). These are frequently absorbed, and disappear during the growth of the embryo, this ultimately filling the embryo-sac; while in other cases they persist and multiply, forming the ALBUMEN of the seed. In the Nymphæaceæ these cells remain, forming an inner Endosperm or Albumen, in addition to that formed from the body of the nucleus. In other cases (those of exalbuminous seeds) the embryo not only displaces these internal endosperm-cells, but in the course of its growth causes the absorption of the tissue of the nucleus, and ultimately constitutes the entire seed, enclosed only by the true integuments. The remaining characters are given under ALBUMEN and EMBRYO.

The notion formerly entertained by Schleiden and his followers, that the embryo-cell was formed by the end of the pollen-tube which penetrates the micropyle, is now given up. The acerbity of feeling caused by opposite views upon this now conceded point will long be remembered. It should caution microscopists against the too ready acceptation of the results even of the greatest authorities and against the repudiation of the work of conscientious observers who do not credit "recognized" opinions.

Tulasne is in doubt whether the germinal vesicles exist before the pollen-tube enters the micropyle. We have certainly seen them before; but we believe they do not possess a cellular coat before impregnation. Observations on the ovule of *Santalum album* have led us to conclude that they receive the influence of the pollen while in the state of nucleated protoplasmic corpuscles, analogous to the unimpregnated spores of FUCUS; and this view has since been supported by the later observations of Schacht, although Hofmeister and Radlkofer maintain that the germinal bodies possess a cell-membrane before impregnation.

In the Gymnospermous Flowering Plants (Coniferæ, &c.) the ovule, consisting of a cellular *nucleus* and a single coat, is placed upon an open carpel, and its widely-open micropyle receives the pollen-grain. At the period of impregnation, the embryo-sac is a cavity deeply seated in the tissue of the nucleus; it is formed by the coalescence and expansion of several cells (in the Yew there are often at first three embryo-sacs). In the embryo-sac a number of free nuclei soon appear, and numerous free (endosperm-) cells are formed. In many of the Abietineæ this goes on until the spring following the impregnation. Ultimately the embryo-sac is found to have increased to more than twenty times its original size, with the endosperm-cells applied in layers over the inside of its walls, increasing in number until the cavity is filled up. Then a certain number of cells (from three to eight in different genera), situated near the micropyle end, but each in the layer next but one to the wall of the embryo-sac, become enlarged, and the cells intervening between these enlarged ones (secondary embryo-sacs) and the wall of the original embryo-sac become divided, by two per-

pendicular septa standing at right angles, into four cells. A central intercellular passage then appears at the contiguous angles of these four cells. These new bodies, which closely resemble the archegonia of the LYCOPODIACEÆ, were called *corpuscula* by Mr. Brown, who discovered them.

Free cells (or perhaps merely protoplasmic masses) are next formed in the secondary embryo-sacs of the corpuscula, several at the upper, one at the lower end. The pollen-tubes now advance, breaking down the tissue of the nucleus, until their points reach the *corpuscula*; and one then makes its way down the intercellular canal of each, to reach its secondary embryo-sac; the free cell (?) at the base of this (*germinal vesicle*) then becomes divided into four collateral cells; these multiply again; and subsequently the cellular body (*proembryo*) so formed breaks through the base of the secondary embryo-sac, and grows down in the substance of the lower part of the nucleus, which is now in a state of semisolution. The proembryo then separates into four cords (corresponding to its four primary cells); and these filaments (*suspensors*) terminate in rounded cells, each of which is an *embryonal cell*; so that there are now four times as many rudimentary embryos as there are corpuscula. Out of all these, only one ultimately remains and becomes perfectly developed; the rest are absorbed during the ripening of the seed. In the latter, the perfect embryo is found lying in a mass of albumen formed of the nucleus; its *radicle*, developed at the point of junction of the suspensor, never becomes very clearly defined at its extremity, but remains organically continuous with the albumen.

Other points relating to the development of ovules will be found under POLYEMBRYONY, SEEDS, and CELL-formation.

The methods of investigating the development of ovules are simple in their nature, but rather difficult in practice. The ordinary plan is to place an ovule between the thumb and fore finger of the left hand, and with a very sharp lancet cut it into two unequal pieces, in the direction of the axis. The larger of the two being then laid on its flat side on the finger (by the aid of a mounted needle), another slice is made so as to leave a section preserving all the central part of the ovule. This adheres either to the finger or the lancet; and a drop of water should be placed on it to free it; then it may be transferred to a slide with a very fine camel's-hair pencil. Examined under a low power (a half-inch), it will probably be found to require further dissection, with exceedingly fine needles, under a simple lens; sometimes mere pressure is of service. For the minute details, the quarter and eighth object-glasses will require to be applied. We have found ovules which have been kept in spirit easier to dissect; when fresh, the cell-membranes are excessively delicate. It need scarcely be added that ovules require to be examined in all stages in order to understand their developmental characters; and the student must not be disheartened by the failure of a large proportion of his sections to afford satisfactory observations.

BIBL. R. Brown, *Appendix to King's Voyage*, 1826; *Observ. on the Orchideæ*, *Linn. Trans.* 1833; Mirbel and Spach, *Ann. des Sc. Nat.* 2 sér. xx. p. 257; Mohl, *Bot. Zeitung*, 1847, 1855; Müller, *ibid.* 1847; Schleiden, *Nova Acta*, xix. p. 29; *Grundz. d. Bot.*; Hofmeister, *Entsteh. d. Embryo*, Leipsic, 1849; *Verg. Untersuch. höher. Crypt. &c.* 1851; Cobbold, *Qu. Mic. Jn.* i. p. 90; Hanstein, *Qu. Mic. Jn.* 1873, p. 51; *Flora*, 1857; Tulasne, *Ann. des Sc. Nat.* 3 sér. xii. p. 21, 4 sér. iv. p. 65; Schacht, *Entw. des Pflanzenembryo*; *Verhandl. Nederland. K. Inst.* 1850; *Beitr. z. Anat. u. Phys.* Berlin, 1854; *Jahrb. d. wiss. Bot.* i. 1857; *Botan. Zeitung*, 1858; Crüger, *Bot. Zeit.* 1851, 1856; Radlkofer, *Entsteh. des Embryo*, Leipsic, 1856; Henfrey, *Linn. Trans.* xxi. p. 7, *ibid.* xxii. p. 69; *Trans. Brit. Assoc.* 1856; Bentley, *Man. Bot.*; Henfrey, *Elem. Course* (Masters); Chatin, *Ann. d. Sci. Nat.* xix. 1874, p. 1.

OVULITES, Lamarck (*Oveolites*).—A large elegant one-celled hyaline Foraminifer (monothalamous or monostegian); either ovoid, sausage-shaped, or like a drumstick; shell porous, with large terminal apertures.

Fossil; abundant in the Eocene of Grignon, Hauteville, &c., France; rare in the Miocene of San Domingo.

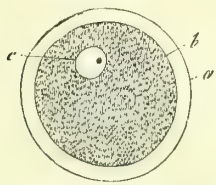
BIBL. Parker & Jones, *Ann. N. H.* 3. v. 292; Carpenter, *Introd. For.* 179.

OVUM OF ANIMALS.—Several points in regard to the structure of the ovum, and the nature of the changes which it undergoes at different periods of its development, are in doubt and obscurity.

The first perceptible trace of the ovum existing within the ovary is formed by a very minute granule or globule, not surrounded by a cell-wall. This gradually

enlarges; and when it has attained a certain size, being still very minute, a smaller spherical globule forms in its interior. The minute internal globule is the *germinal spot*; and the external globule is the so-called *germinal vesicle*. It appears, however, that in some cases the germinal spot is formed first, and the germinal vesicle subsequently. When these have still further grown, a cell-wall separated by a slight interspace forms around the germinal vesicle; and this interspace contains a transparent liquid. Minute granules then arise in the liquid, which becomes inspissated; and subsequently a number of globules of sarcode — *yolk-globules*—become perceptible in it; this mass forms the *yolk*; and the surrounding membrane is the *vitelline membrane*. As the ovum attains further development, albuminous layers are deposited upon and fused with the vitelline membrane forming the *zona pellucida* or chorion (fig. 552 *a*),

Fig. 552.



Human ovum from a Graafian vesicle of moderate size. *a*, zona pellucida; *b*, vitelline membrane and outer boundary of the yolk; *c*, germinal vesicle with the germinal spot.

Magnified 250 diameters.

which appears as a white ring. The yolk-globules are sometimes transparent, or slightly granular; at others they contain one or several vacuoles, and are frequently aggregated into little groups. The yolk, as it approaches maturity, frequently becomes coloured. It is usually whitish or pale-yellow in the Mammalia, Reptiles, and Fishes, bright-yellow or reddish in many Birds, and often green, blue, violet, or red in the Invertebrata. In the yolk of the ova of reptiles and fishes, crystalline plates are met with, consisting of an albuminous substance, allied to Hæmatoidine.

Viewing the ovum as a simple cell, the germinal spot represents the nucleolus, the germinal vesicle the nucleus, the vitelline membrane or zona pellucida the cell-wall, and the yolk the cell-contents.

Some authors consider that the vitelline membrane is formed after the chorion.

The ovum of man and the mammalia differs from that of the lower animals in its remarkably small size, which depends upon the extremely small quantity of yolk entering into its composition. The mature ovum of man and mammalia averages about 1-200 to 1-150″ in diameter, being rarely 1-100″. Another peculiarity consists in their ova, instead of being in immediate contact by means of their chorion or outer envelope with the stroma of the ovary, or being loose within the cavity of the latter, as in other animals, being enclosed in distinct larger cells—the Graafian vesicles.

On the escape of the ovum from the ovary, the phenomena which ensue vary according to whether the ovum has been impregnated or not. In both cases the germinal vesicle and spot disappear; an interspace, filled with albuminous liquid, occurs between the yolk and the zona pellucida; the ovum becomes covered with cilia, and undergoes a regular motion of rotation; and certain movements and changes in form of the yolk-substance, which forms Amœba-like processes, have been noticed. In the unimpregnated ovum, decay and decomposition subsequently take place.

The essential part of the process of impregnation consists in the penetration of the yolk by the spermatozoa, and their subsequent solution in it. This takes place either through the micropyles or the radiate canals, or directly into the naked yolk.

In the impregnated ovum, the germinal vesicle soon disappears, the chorion becomes thinner, the ovum grows, and the yolk begins to undergo the process of segmentation; but just before this process commences, one or two globules separate from the substance of the yolk, being apparently pressed out of it, and occupy the interspace between the yolk and the chorion: these globules subsequently dissolve in the liquid.

The process of segmentation has been described under CELL (p. 134); but according to another account, it takes place thus:—At first a notch or slight indentation appears on some part of the surface of the yolk; this becomes deeper and deeper, so as to encircle the yolk with an annular depression. Soon after the commencement of this, a clear spot appears in the centre of each circumscribed portion of the yolk. The depression becoming deeper, the yolk is divided into two distinct portions. The process is continued in the case of each of these in exactly the same manner, and in

that of the segments arising from their subdivision also, each simultaneously acquiring a clear spot, until the yolk appears entirely composed of innumerable small bodies having the appearance of nucleated cells. Finally these become very minute, and the yolk acquires much the appearance it had before impregnation. Cells then form in the yolk, as in an ordinary blastema, from without inwards, and from the spot originally occupied by the germinal vesicle as a centre; and from these the tissues of the embryo are formed.

According to this description, which is most probably correct, the segmentation is not a process of cell-division or endogenous cell-formation, and the nuclear spots would correspond to portions of the yolk substance from which the granules and globules of sarcode were absent.

In unimpregnated ova, segmentation takes place to a certain extent, but irregularly and incompletely.

In the impregnated ova of some animals, as in some of the Batrachia, most fishes and Cephalopods, the segmentation is only partial, a portion of the yolk remaining as at first.

In some of the Mammalia, the zona pellucida is traversed by very fine radiating lines (canals), which are best seen in the ova immersed in water.

In the lower Vertebrate animals, the ova are often covered by new layers, secreted by the ovaries, as in the Batrachia (frog, &c.), where a thick gelatinous coat is present. In the osseous Fishes, the vitelline membrane is frequently elegantly sculptured, and finely and closely punctate from the existence of minute canals traversing its substance. A second coat is also present, and sometimes a third or albuminous layer. In many of the Cyprinoidea, this layer is represented by small radiate cylinders. In several Fishes, as is so general amongst the Invertebrata, especially Insects (EGGS), the vitelline membrane or chorion exhibits a faceted or sculptured appearance, derived from the impression of the epithelium lining the ovarian passages.

In addition to the fine canals traversing the membranes of the ovum, one or more large canals or apertures are frequently met with resembling the micropyles of vegetable ovules, and receiving the same names. These micropyles are most distinct in the ova of fishes and insects.

The study of ova and their changes is very difficult. The most favourable objects for the purpose exist perhaps in those of the aquatic Mollusca; the ova of insects, as the large species of *Musca*, of species of *Pulex*, &c. are also easily accessible. Some important results have been obtained with the ova of the frog (frog's spawn).

BIBL. Kölliker, *Mikr. Anat.* ii.; Al. Thomson, *Cycl. Anat. &c.*, art. *Ovum*; Vogt, *Physiol. Briefe*; Newport, *Phil. Trans.* 1851 and 1853; Siebold, *Vergleich. Anat.*; V. Beneden, *Ann. des Sc. Nat.* 3 sér. xiii.; Meissner, *Sieb. & Köllik. Zeitsch.* vii. pp. 208, 272; Leuckart, *Müll. Archiv*, 1855; Claparède, *Bibl. Univ. d. Genève*, 1855; *Ann. Nat. Hist.* 1856, xvii.; Bischoff, *Sieb. & Köll. Zeit.* vi. 377; Radlkofer, *Befruchtungs.* Leipsic, 1857; Kölliker, *Entwick. d. Mensch. u. d. höheren Thiere*, 1861; Truman, *Mo. Mic. Jn.* ii. p. 185; Beneden & Bessels, *Mo. Mic. Jn.* 1869, p. 41; Kupffer, *Mo. Mic. Jn.* 1869, p. 47; Kowalevski, *Embryologische Studien an Würmern und Arthropoden*; *Mém. de St. Pétersbourg*, xvi. no. 12, 1871; Moseley, *Qu. M. J.* 1871, pp. 11, 151; Klein, *M. M. J.* vii. 1872, p. 193; Beale, *Trans. Mic. Soc.* July 1867; *How to Work*, p. 307.

OVUM OF PLANTS. See OVULE.

OXALATES. See the bases.

OXYR'RHIS, Duj.—A genus of Infusoria, belonging to the family of Cryptomonadina.

Char. Body ovoid-oblong, rugose, obliquely notched in front and prolonged into a point; several flagelliform filaments arising laterally from the bottom of the notch.

O. marina (Pl. 24. fig. 54). Body colourless, subcylindrical, rounded behind; marine; length 1-500″.

BIBL. Dujard. *Infus.* p. 347; Pritchard, *Infus.* 513.

OXYT'RICHA, Bory, Ehr.—A genus of Infusoria, of the family Oxytrichina.

Char. Closely resembling *Stylonychia*; but the front part of the body is not produced. (See analysis of genera in OXYTRICHINA.)

Most of Ehrenberg's species belong to other genera.

1. *O. pellionella*, E. (Pl. 24. fig. 52). Body whitish, smooth, slightly depressed, equally rounded at the ends, often somewhat broader in the middle; head not distinct; mouth ciliated; tail with bristles. Aquatic; length 1-720 to 1-280″.

2. *O. gibba*, E. (Pl. 24. fig. 53). Body white, lanceolate, obtuse at each end, ven-

tricose in the middle; ventral surface flat, with a double row of setæ; mouth large, rounded. Aquatic; length 1-240″.

According to M. Haime, *Oxytricha* is the larva of *Aspidisca.*

Bibl. Ehr. *Infus.* p. 363; Duj. *Infus.* p. 416; J. Haime, *Ann. des Sc. Nat.* 3 sér. xix. 109; Clap. et Lachm. *Etudes,* 139.

OXYTRICHI'NA.—A family of Infusoria Ciliata. See Infusoria, the classification of Claparède et Lachmann.

Char. Carapace absent, but the cuticula is tough; body furnished with vibratile cilia and setæ, or cirri, and non-vibratile styles or hooks; shape of body depressed. They are the crawling Infusoria; and their styles, hooks, and marginal cirri occasionally split longitudinally, and are transformed into bundles of five cilia, each of which moves independently. The frontal cirri do not divide in this manner. The contractile vesicle is solitary; the œsophagus is short, and the anus is situated on the ventral surface, not far from the end.

The Oxytrichina are divided into the following genera:—

Oxytrichina.	Marginal cirri	Foot-cirri in regular rows, longitudinal or oblique		The anterior part of the body not prolonged as a neck, furnished with cirri	1. *Oxytricha.*
				The anterior part of the body neck-like, and covered with cirri	2. *Stichochæta.*
		Foot-cirri not arranged in rows			3. *Stylonychia.*
	No marginal cirri	With frontal cirri	Foot-hooks exist	No dorsal bristles	4. *Euplotes.*
				Dorsal bristles	5. *Schizopus.*
			No foot-hooks		6. *Campylopus.*
		Without frontal cirri			7. *Aspidisca.*

Bibl. Ehr. *Infus.* p. 362; Pritch. *Infus.* 639; Clap. et Lach. *Etudes,* 168.

OXYUR'IS, Rud. See Ascaris.

OY'STER (*Ostrea*).—A genus of Lamellibranchiate Mollusca.

The gills of *O. edulis,* the common oyster, show the ciliary movement; but it is not so easily seen in this as in the marine mussel.

The shells of the fry or 'embryo oysters' exhibit the black cross and an imperfect set of coloured rings with polarized light.

P.

PACCHIONIAN BODIES, or GRANULATIONS.—Formerly called glands, are not found during early life, and not invariably in adult or old age; they are therefore more or less morbid products.

They are numerous milk-white projections, which are chiefly found on either side of the longitudinal sinus along the edges of the hemispheres of the brain. Under a low magnifying-power they appear as groups of papillæ, some of which are simple, while others bifurcate once or even twice; they become pedunculated as they grow larger, but without separating from their base. They are absolutely nonvascular, and consist of wavy connective tissue, poor in corpuscular elements, which grows from a thin but incessantly reversed layer of subepithelial embryonic tissue. The epithelium with which they are clothed consists of several strata, in marked contrast to the normal epithelium of the Arachnoid membrane.

Bibl. Todd and Bowman, *Phys. Anat.* vi.; L. Meyer, *Virch. Arch.* xix. 288; Bastian, *Trans. Mic. Soc.* xiv. 36; Rindfl. *Path. Hist.* ii. 354; *Syd. Soc. Tr. Baxter.*

PACHNOC'YBE, Berk.—A genus of Isariacei (Hyphomycetous Fungi), somewhat confused by authors with *Doratomyces,* Corda, and *Periconia,* Nees. These plants have an erect filiform stem, composed of conjoined filaments, capitulate above, the head being pruinose (not flocculent), with crowded simple spores. The pedicels are mostly brownish or blackish, the spores light-coloured; the entire plants from 1-24 to 1-6″ high. Several species occur on rotten wood, stems, &c.

Bibl. Berk. Hook. *Brit. Flor.* ii. pt. 2. p. 333; *Ann. Nat. Hist.* 2 ser. v. p. 465; Fries, *Summa Veg.* p. 467.

PACHYDER'MON, Claparède.—Considered to be a parasitic organism of Oligochæta by Claparède. Allied to *Opalina*; it is most probably a Spermatophor.

Bibl. Claparède, *Rech. Anat. s. l. Oligochètes*; E. Ray Lankester, *Qu. Mic. Jn.* 1870, p. 143.

PACHYG'NATHUS, Dugès.—A genus of Arachnida, of the order Acarina, and family Trombidina.

Char. Palpi conical, last joint scarcely forming a claw; mandibles stout, chelate; body entire, narrowed in front; coxæ distant; legs gressorial, sixth joint very long, seventh very short; anterior legs longest and stoutest.

P. velutinus (Pl. 2. fig. 34), the only species. Found in autumn, under damp stones. Hairs covering the body short, flat, and

curved, giving it a velvety aspect. Body inflated, narrowed in front, the narrowed portion with two projecting brownish eyes. Insertions of the legs in two groups, not far distant from each other or from the median line; second pair of legs shortest; in all the sixth joint very long, the seventh very short and narrow (*b*), as in *Tetranychus, Megamerus*, and *Raphignathus*; claws two, large; rostrum projecting; palpi (*a*) short, about twice the length of the labium; mandibles very large and stout at the base. Movement slow.

BIBL. Dugès, *Ann. des Sc. Nat.* 2 sér. ii. p. 54; Gervais, *Walck. Aptèr.* iii. p. 171.

PACHY'MA, Fr.—A supposed genus referred to Sclerotiacei, but probably a condition of certain roots, the substance being converted into pectic acid. It is well known in the United States under the name of Tuchahoo.

BIBL. Fr. *Syst. Myc.* ii. p. 242; Berk. *Int. Crypt. Bot.* p. 254.

PACHYMATIS'MA, Bowk.—A genus of Marine Sponges.

Distinguished by the fleshy, crust-like, not cellular nor elastic mass, covered by a thick skin, and perforated by scattered orifices; the interior beset with siliceous acicular and stellate spicula.

P. Johnstonia.

BIBL. Bowerbank, *Monogr. Brit. Spong. Ray Soc.*

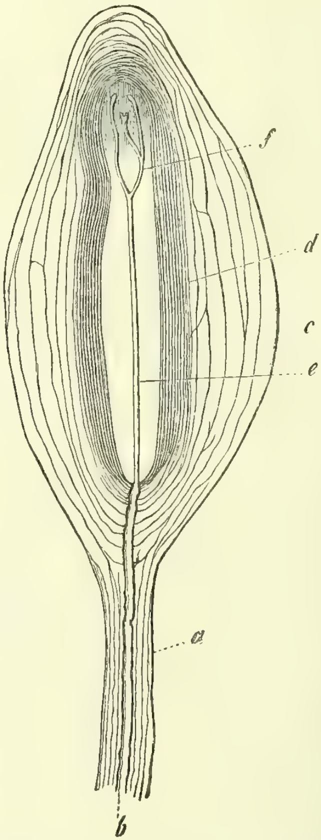
PACHYPHLŒ'US, Tul.—A genus of Tuberacei (Ascomycetous Fungi), with a common warty integument opening by a terminal aperture with a distinct base, clavate asci, and spherical sporidia. Three species occur in Great Britain.

BIBL. Tul. *Fung. Hyp.* p. 130; Berk. and Br. *Ann. Nat. Hist.* xiii. p. 359, xviii. p. 79; Berk. *Outl.* p. 377; Cooke, *Handb.* p. 743.

PACINIAN or VATER CORPUSCLES.—These curious organs are found as terminations or appendages of the spinal sensitive nerves in the skin and subcutaneous tissue of the palm of the hand, the sole of the foot, the fingers and toes, in the sympathetic semilunar ganglia, the mesentery, &c.

They are elliptical or pear-shaped, whitish, and about 1-25 to 1-6″ in diameter. Each consists of from twenty to sixty concentric layers of areolar tissue (fig. 553), separated by interspaces. They surround a cavity filled with soft abundantly nucleated and very easily alterable material, which undergoes coagulation after death, and into the interior of which the nerve-fibres penetrate. The nerve-fibres are of the medullated kind, and before entering the corpuscle have the tubular sheath and the white substance of Schwann besides the axis-cylinder. The tubular sheath of a nerve becomes continuous with the connective-tissue layers, and the white substance is represented by the material in the cavity; but the axis-cylinder passes into the cavity to its distal extremity, where it ends in a terminal bulb. The axis-cylinder appears to be fibrous

Fig. 553.



A human Pacinian corpuscle. *a*, stalk; *b*, nerve-fibre within it; *c* outer, *d* inner layers of the sheath; *e*, pale nerve-fibre in the central cavity; *f*, its termination.

Magnified 350 diameters.

when magnified 1000 linear, and the terminal bulb to consist of a finely granular substance, from which the terminal fibrils can be readily distinguished.

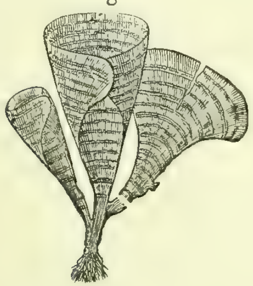
The Pacinian corpuscle is, then, a remarkably thickened end of a nerve-fibre. A careful examination proves that the sheath consists externally of a homogeneous nucleated membrane, on which, after immersion in a solution of nitrate of silver, traces of an epithelium can be traced. At a certain point it breaks up into the concentric capsules that constitute the bulk of the corpuscle. These capsules, formed of expanded tubular nerve-membrane, are apparently structureless; the external are thickest, and are separated by fluid, but the inner are thin and in close apposition. On section, after the action of acetic acid, numerous oblong nuclei come into view, which become red under chloride-of-gold solution. Solution of nitrate of silver brings out markings like those of lymphatics. A blood-vessel penetrates the capsule, and forms a plexus between the outer layers.

The Pacinian corpuscles are not found exclusively attached to the human nerves, but are met with also on those of many Mammalia, and are very numerous in the skin, the beak, and the tongue of birds. They are very readily examined in the mesentery of the cat. It is an error to suppose that branches of nerve pass in between the layers of the corpuscle.

Bibl. Kölliker, *Mik. Anat.* ii.; M. Schultze, *in Stricker's Hum. and Comp. Hist.*

PADI'NA, Adanson.—A genus of Dictyotaceæ (Fucoid Algæ), containing one species, *P. Pavonia* (fig. 554), found rarely in summer and autumn on the south coast of

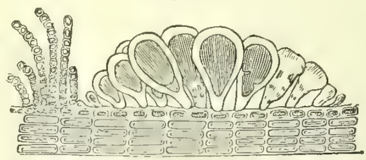
Fig. 554.



Padina Pavonia.
Frond, one third natural size.

England. The fan-shaped or reniform fronds grow in tufts, and are 2 to 5" high, sometimes entire, sometimes cleft (fig. 554). They are marked with concentric zones. The substance is parenchymatous—the number of layers of cells diminishing, with the thickness and solidity, from the base to the edges. The back of the frond is covered by a layer of cells much smaller than the rest, forming a kind of epidermis, which ultimately acquires a thickish cuticular layer. The growing edge of the frond is rolled backwards (circinate) and fringed. The fructification occurs in linear concentric sori, on the coloured zones of the frond. The pear-shaped *spore-sacs* (fig. 555) originate from cells of the epidermal layer, which

Fig. 555.



Vertical section of a frond at a concentric zone, made in a radial direction, cutting through the sorus of spore-sacs and a line of hairs. The indusial layer of cuticle has been removed.

Magnified 50 diameters.

take on special development, and in the course of their growth push up and finally burst through the loosened cuticular layer which originally clothed them, so that the latter forms a kind of indusium like that of the Ferns. The spore-sacs produce each four spores, which separate after their escape from the sac. The zones of the sori alternate with zones composed of tufts of jointed hairs placed in corresponding lines (fig. 555). Thuret states that he has never found *antheridia* hitherto, and he believes that Agardh mistook the hairs or paranemata for them.

Bibl. Harvey, *Brit. Mar. Alg.* p. 37, pl. 6 C; *Phyc. Brit.* pl. 91; Grev. *Alg. Brit.* pl. 10; Agardh, *Sp. Alg.* i. p. 112; Nägeli, *Neuer. Algensyst.* p. 180, pl. 5; Thuret, *Ann. des Sc. Nat.* 4 sér. iii. p. 12; Kütz. *Phyc. general.* pl. 22; Al. Braun, *Rejuvenescence, &c.* (*Ray Soc. Vol.* 1853), p. 79.

PALATES, Molluscan. See Tongue.

PALMEL'LA, Lyngbye (Red snow and gory dew).—A genus of Palmellaceæ (Confervoid Algæ), of which the best known example is the common *P. cruenta* (Pl. 3. fig. 3 *a*). This plant, very common on damp walls in shaded places, appears at first in the form of rosy gelatinous patches; these spread and become confluent until the mass extends sometimes over a great extent of

surface, as a tough, gelatinous, irregular mass, of the colour and general appearance of coagulated venous blood; when dried up in this state, it forms a horny, somewhat crumbling stratum; if placed in water, portions float to the top in pellucid rosy masses of jelly. In its natural habitats its colour and general appearance become disguised when old by the admixture of *Oscillatorieæ* and other Confervoid growths.

When placed under the microscope, the frond appears to be composed of a colourless homogeneous jelly, in which are imbedded globular cells, single or in pairs (from division), of a beautiful rose-colour (fig. 3, *a*, *b*); by the application of reagents, these may be shown to possess a proper membranous coat (*c*). The contents of the cells appear uniformly granular (*b*, *c*); and it would appear that, besides increasing by division, the cells also burst and discharge their contents, since patches of minute granules occur imbedded in the jelly (lower figs. of *b*), probably destined to grow up into the ordinary cells. No zoospores, nor the remarkable phenomena generally that occur in *Protococcus*, have yet been observed in this, which appears to be a very distinct genus. The jelly of full-grown fronds (which appears to be derived from the gelatinous softening of the coats of the parent cells of the successive generations of cells) is often overgrown and traversed by minute filamentous structures, which at first sight seem to belong to it; but on the application of a high power are found to consist of a very minute Nostochaceous plant, apparently the *Anabæna subtilissima* of Kützing, or *Vibrio bacillus*, Ehr. (Pl. 3. fig. 21), which we find to occur commonly among the Palmellaceous Algæ.

P. cruenta has received an extraordinary number of generic names: *Tremella*, *Byssus*, *Thelephora*, *Sarcoderma*, *Phytoconis*, *Porphyridium*, *Globulina*, *Coccochloris*, and *Chaos* (!).

From the examination of specimens of the true "red snow," brought home by Captain Parry (for which we are indebted to Mr. Brown), we incline to regard this as a *Palmella*, distinct generically from the *Protococcus* or *Hæmatococcus pluvialis* of the German writers, with which it is commonly associated. Our specimens consist of a tough, colourless, gelatinous substance, containing globular cells differing only in size (Pl. 3. fig. 3 *d*) from those of *Palmella cruenta*; and in the jelly occur also abundance of the minute granules or cellules, which are the discharged contents of the larger cells. The red cells of the red-snow plant turn green when exposed to light, if kept moist. An exactly similar plant has been given us by Mr. Oliver, from Crag Lough, Northumberland, in a fresh condition; and we have never been able to detect any moving forms in it. Further particulars are given on this subject under RED SNOW and RUBEFACTION OF WATER, and PROTOCOCCUS.

Other species of *Palmella* are described; but most of them are too imperfectly known to allow of definite characters being given; *P. rosea* is perhaps a good species. The forms with a definite frond formerly placed here (*P. protuberans, botryoides*, &c.) will be found under COCCOCHLORIS.

BIBL. *Eng. Botany* (as *Tremella cruenta*), pl. 1800; Greville, *Sc. Crypt. Alg.* pl. 205; Meneghini, *Monogr. Nostoc.* (*Trans. Turin Acad.* ser 2. v.), pl. 6; Hassall, *Brit. Fr. Alg.* pl. 80; Nägeli, *Einzell. Alg.* p. 66, pl. 4 D; Kütz. *Sp. Alg.* p. 211; Rabenht. *Fl. Eur. Alg.* iii. 32. See also under RED SNOW.

PALMELLA'CEÆ.—A family of Confervoid Algæ, consisting of gelatinous or pulverulent masses, growing on damp surfaces, in fresh water or in the sea; composed of globular or elliptical cells, either more or less adherent together into a definite or indefinite pseudo-membrane or frond, or loosely aggregated within a definitely or indefinitely formed gelatinous matrix, or loosely coherent in the form of a pulverulent crust. The Palmellaceæ include forms which are embryonic, and which constitute a part of the life-cycle of other cellular plants (see LICHENS, MOSSES, LYNGBYA). Some authors have imagined that the cells of *Coccochloris* or *Palmella* are attached to filaments included in the gelatinous frond: this seems an error (see PALMELLA). Yellowish or bluish green, or red, often varying from green to red, and *vice versâ*, during the course of development. Increased by cell-division into two or four, and by ciliated zoospores. Many exhibit three forms:—1. active; 2. quietly vegetating by subdivision; 3. resting form, with a tough membrane. We include here, for the sake of convenience, not only the true Palmellaceæ, where there is a frond composed of a number of cells held together by mucus, but also all those Unicellular Algæ which, from their mode of increase, are found living socially or in masses which appear like Palmelloid plants.

Synopsis of Genera (see genera).

* *Plants with a frond composed of colourless gelatinous substance.*

† Frond amorphous.

Palmella (Pl. 3. fig. 3); *Microhaloa.*

†† Frond definite.

Glœocapsa (Pl. 3. figs. 4 & 13); *Botrydina* (Pl. 3. fig. 9); *Coccochloris* (Pl. 3. fig. 6); *Clathrocystis*; *Merismopœdia* (Pl. 3. fig. 12); *Urococcus* (Pl. 3. fig. 7); *Hormospora* (fig. 336, p. 382); *Tetraspora* (Pl. 3. fig. 10); *Hydrurus* (Pl. 3. fig. 8); *Palmodictyon.*

** *Plants composed of single cells, either solitary or united in small numbers into families (Unicellular Algæ).*

† Solitary cells.

Schizochlamys; *Chlorosphæra* (Pl. 45. fig. 4); *Characium* (Pl. 45. fig. 1); *Apiocystis* (Pl. 45. fig. 5); *Codiolum* (Pl. 45. fig. 6); *Hydrocytium* (Pl. 45. fig. 2); *Ophiocytium* (Pl. 45. fig. 11); *Sciadium* (Pl. 45. fig. 3); *Chytridium* (Pl. 45. fig. 7); *Pythium* (Pl. 45. fig. 8); *Sarcina* (Pl. 3. fig. 5).

For PROTOCOCCUS see VOLVOCINEÆ.—*Hæmatococcus* = PROTOCOCCUS and PALMELLA; *Porphyridium* = PALMELLA; *Chlamydococcus* and *Chlamydomonas* = PROTOCOCCUS; *Sorospora* = GLŒOCAPSA?; *Cylindrocystis*, Bréb. = COCCOCHLORIS; *Polycystis*, Kütz. = CLATHROCYSTIS; MICROCYSTIS and ANACYSTIS = MICROHALOA ?. Numerous other genera of doubtful value and imperfect character are given by Nägeli (*Einzell. Algen*), as *Exococcus, Chroococcus, Synechococcus, Stichococcus, Cytococcus, Dactylococcus, Nephrocytium, Dictyosphærium, Glœocystis, Aphanothece, Glœothece, Cœlosphærium, Aphanocapsa, Palmodactylon*; by Kützing (*Species Algarum*), as *Botryococcus, Botryocystis, Trichodictyon, Trichocystis, Palmophyllum, Gomphosphæria. Chlorococcus* and *Pleurococcus* are probably forms of *Protococcus*, or gonidia of Lichens.

BIBL. Al. Braun, *Rejuven. &c., Ray Soc.* 1851, passim; *Alg. Unicell. Gen. Nova*, Leipsic, 1855; *Ueb. Chytridium*, Berlin, 1856; Nägeli, *Einzell. Algen*, Zurich, 1849; Kütz. *Species Algar.* and *Tab. Phycol.* i.; Cohn, *Nova Acta A. L. C. N. C.* xxiv.; Rabenht. *Fl. Eur. Alg.* iii. See also the genera.

PALMELLI'NA, Radlk.—A doubtful genus allied to *Palmella*, but probably one of the Fungi. The species have extremely small cells, some of which are elliptical, and others circular in outline; they are included in a flocculent thallus. Found in fresh water. Continental.

BIBL. Rabenht. *Fl. Eur. Alg.* iii. 35.

PALME'RIA, Grev.—A genus of Diatomaceæ from Hong Kong.

BIBL. Grev. *Ann. Nat. Hist.* 1865, xvi. 1.

PALMODAC'TYLON, Näg.—A supposed genus of Unicellular Algæ, germinating spores of a Moss?

P. varium consists of a group of radiating bodies, some of which are entire cells, and others multicellular. The ends are rounded; and there are numerous green spherical masses in each cell. The cell-wall bursts in definite directions, and sets free active gonidia.

Hab. Germany and Switzerland; aquatic.

BIBL. Nägeli, *Einzell. Alg.* pl. 2. fig. B; Rabenht. *Fl. Eur. Alg.* iii. 44.

PALMODIC'TYON, Ktz.—A genus of Palmellaceæ (Confervoid Algæ), described as possessing a frond which appears like a delicate network to the naked eye, of gelatinous texture, and consisting of anastomosing branches, each composed (in *P. viride*) of a single or double row of large vesicular cells, 1-600 to 1-960″ in diameter. These contain a pair of elliptical green cellules, 1-3000″ in diameter, which ultimately escape as active zoospores. This genus appears identical with *Trypothallus*, Hook. and Hervey, and is nearly related to HYDRURUS and TETRASPORA.

P. rufescens, Ktz., doubtfully referred here, is larger; it occurs near Aberdeen.

BIBL. Kütz. *Sp. Alg.* p. 234; *Tab. Phyc.* Bd. i. pl. 31; Rabenht. *Fl. Eur. Alg.* iii. 37.

PALMOGLŒA, Ktz.—A genus of Desmidieæ. Syn. *Mesotænium*, Nägeli; *Trichodictyon*, Ktz. Some of its species have been confounded with those of COCCOCHLORIS and PALMELLA.

BIBL. Archer, *Qu. Mic. Jn.* 1864, p. 124; Carpenter, *The Microscope*, 244; Rabenht. *Fl. Eur. Alg.* iii. 116.

PALMOPHYL'LUM, Ktz.—A genus of Palmellaceæ (Confervoid Algæ). 1 species found in the Adriatic.

BIBL. Rabenht. *Flor. Eur. Alg.* iii. 49.

PALUDEL'LA, Ehr.—A genus of Meesiaceæ, having only one representative, which occurs in Britain, *P. squarrosa* = *Bryum squarrosum*, L.

PALUDICEL'LA, Gervais.—A genus of Polyzoa.

Char. Polypidom fixed, filamentous, dif-

fusely and irregularly branched, coriaceous, consisting of a single row of club-shaped cells arranged end to end; apertures unilateral, tubular, placed near the broad end of each cell; tentacular disk circular, with a single row of free tentacles.

P. articulata. The only species; olive-green; polypes ascidian. Aquatic; diameter of filaments about 1-30 to 1-20″.

BIBL. Johnston, *Brit. Zooph.* p. 405; Allman, *Ann. Nat. Hist.* xiii. 331, and *Proc. Irish Acad.* 1843.

PAM'PHAGUS, Bailey.—A genus of Rhizopoda allied to *Lieberkuehnia* and Gromida. *P. mutabilis* is an amœbiform being, covered with a delicate elastic integument, which, although it presents astonishing changes of forms and offers a certain amount of resistance to internal and external pressure, yet admits of the creature's transfixing itself upon any denser thin portion of matter without any apparent damage. It has not the test-like sheath or coat of *Plagiophrys.* It is very voracious.

BIBL. Bailey, *Amer. Journ. Sci.* art. xv.; Pritchard, *Infus.* 551; Claparède et Lachmann, *Etudes,* 465; Archer, *Qu. Mic. Jn.* 1871, p. 101.

PANDORI'NA, Bory (Pl. 45. fig. 10).—A genus of Volvocineæ (Confervoid Algæ), which we believe to be synonymous with *Eudorina.* It exhibits a great variety of forms, some of which have been described under the name of *P. Morum*, others of *Eud. elegans.* The most characteristic conditions are represented in Pl. 45. fig. 10. *Pandorina* stands midway between *Volvox* and *Stephanosphæra,*—consisting of an ellipsoidal translucent sac of gelatinous consistence, containing, imbedded just below its surface, several zone-like rows of green pear-shaped gonidia, whose two cilia penetrate the gelatinous envelope, and, hanging out free, move the entire organism by their vibration. Two distinct forms occur—one with sixteen, the other with thirty-two gonidia. Where sixteen occur, there are four zones of four gonidia, while where thirty-two exist they stand in four zones of eight, with four at each end (Pl. 45. fig. 10 *a* and *b*). The gonidia have a red spot and a vacuole, like those of *Gonium* and *Volvox.* Rabenhorst states that in *Pandorina* there is no red spot, and that there is but one cilium, whilst in *Eudorina* there are many cilia, and frequently a red spot. These two forms occur together; and evidently the difference arises simply from an additional binary subdivision of the gonidia in the earlier stages of development from the spore. They are often so numerous as to tinge the water of fresh pools green, like *Volvox* and *Protococcus.* They occur of various sizes, from 1-80″ downwards. These forms are multiplied vegetatively by the conversion of each gonidium into a family like the parent, each group acquiring its special envelope and becoming free, apparently by the solution of the parent-envelope.

Two corresponding forms occur with the above, with the sixteen or thirty-two gonidia closely crowded together, instead of standing at wide intervals in the large colourless envelope: it is uncertain whether this form is multiplied vegetatively; but we have seen its gonidia all converted into resting-spores.

The resting-spores are formed out of all or part of the gonidia of a family, after fertilization by the spermatozoids. The latter are minute, fusiform, ciliated corpuscles, produced in large numbers by subdivision of the substance of some of the gonidia; they are set free inside the parent-envelope, and make their way to those gonidia which are to become resting-spores. The impregnated gonidia soon acquire a stout special coat, and their originally green contents turn red. They become free by the solution of the parent-envelope. In germination they turn green again, and by repeated division of their protoplasm form the new families of sixteen or thirty-two, constituting the perfect plant.

BIBL. Ehr. *Infus.* p. 53; Duj. *Infus.* p. 317; Henfrey, *Mic. Trans.* 2 ser. iv. p. 49; Fresenius, *Mus. Senckenb.* ii. p. 187 (1856); Cohn, *Nova Acta,* xxvi. p. 1; De Bary, *Bot. Zeit.* xvi., *Supp.* ii. p. 73 (1858); Currey, *Quart. Journ. Mic. Soc.* vi. p. 213; Carter, *Ann. Nat. Hist.* 3 ser. ii. p. 237; Rabenh. *Fl. Eur. Alg.* iii. p. 99.

PANNA'RIA, Del.—A genus of Lichenacei of the series Placodei. It is the only genus of a subtribe which has the thallus squamulose or granulose, with granular gonima (no gonidia).

BIBL. Leighton, *Brit. Lich. Flor.* p. 164.

PANOPH'RYS, Duj., properly FRONTONIA.

P. chrysalis (Pl. 24. fig. 55). Marine.

BIBL. Duj. *Infus.* p. 491; Claparède et Lachm. *Etudes,* 260.

PANTOT'RICHUM, Ehr.—A genus of Infusoria. See UROTRICHA.

P. lagenula, E. (Pl. 24. fig. 58). Body ovate, equally rounded at each end, yellowish; tegument produced anteriorly in the form of a neck or truncate rostrum; length 1-1080 to 1-580''.

BIBL. Ehrenberg, *Infus.* p. 247; Dujard. *Infus.* p. 388; Clap. et Lachm. *Etudes*, 315.

PA'NUS, Fr. — A genus of Agaricini (Hymenomycetous Fungi), distinguished from *Agaricus* by the tougher substance. The edge of the gills is entire and acute. The British species are few in number, and for the most part nearly allied to Pleuroti, and, with the exception of *P. stypticus*, are probably esculent.

BIBL. *Fr. Ep.* p. 396; Berk. *Outl.* p. 227; Cooke, *Handb.* p. 244.

PAPER.—Only a few general observations can be made under this head. Ordinary paper, as is well known, is generally manufactured from rags of linen or cotton fabrics, so that it consists of a kind of felt of the fibres of cotton or flax; but other substances, such as straw, for instance, are now coming into use, from the growing scarcity of rags. The manipulation to which the material is subjected, together with the effect of frequent washing in the case of rags, affects the characters of the fibres to some extent; and the cellulose is in some cases already brought into that state in which iodine colours it blue. The addition of sulphuric acid and iodine colours the fibres of most papers blue; and care must be taken on this account to avoid errors from the accidental presence of them when blotting-paper is used to absorb these reagents when applied to objects on a slide. The determination of the nature of the filaments of which a paper is composed, by the aid of the microscope, would require a very thorough knowledge of the characters of vegetable fibres, and we should imagine could scarcely be very decisive in most cases, except so far as distinguishing between classes of substances, as between parenchymatous and filamentous or fibrous substances, &c.

Rice-paper, as it is termed, is a totally different material, consisting of thin layers, cut by a peculiar operation, of the pith of *Aralia papyrifera*, a Chinese Araliaceous tree: this consists of parenchymatous cellular tissue.

Papyrus, consisting of pressed superposed laminæ of the pith of the *Papyrus* plant (*Papyrus antiquorum*, a kind of Sedge), exhibits the lax parenchymatous structure characteristic of similar tissues, such as the Rushes, &c.

PAPER, METEORIC, and AEROPHYTES. —The structure and origin of these substances are the same as those of the so-called natural flannel (FLANNEL). They were formerly regarded as of meteoric origin. They have been observed in some instances to fall from the air, having been wafted perhaps many miles from their place of formation by whirlwinds and hurricanes.

BIBL. Ehr. *Abhandl. d. Berl. Akad.* 1838.

PAP'PUS. — The free portion of the calyx of the Compositæ. It may be feathery, spiny, membranous, or hairy.

PAPULAS'PORA, Preuss.—A genus of Mucedines (Hyphomycetous Fungi), consisting of a decumbent articulate mycelium, sending up erect pedicels bearing a cellular head, each cell supporting an oblong spore.

P. sepedonioides has been found on rice-paste.

BIBL. Berk. and Broome, *Ann. Nat. Hist.* ser. 2. xiii. p. 462; Berk. *Crypt. Bot.* p. 305, fig. 69 *b*.

PAPY'RUS.—The pith of the stems of the *Papyrus antiquorum* (modern papyrus from *P. syriacus*), cut into slices, which are laid upon one another and pressed so as to form a compact stratum. Sections display the parenchymatous tissue more or less deformed by pressure.

PARACY'PRIS, G. O. Sars. — One of the *Cypridæ*, near *Aglaia* and *Potamocypris*. Valves siliquose, highest in front. Second pair of jaws have a branchial appendage. Upper antennæ 7-jointed, with very short setæ; lower stout, clawed. Postabdominal rami large, clawed at end. Marine. One British species, rather common; fossil also in raised beaches &c.

BIBL. Brady, *Trans. Linn. Soc.* xxvi. 377.

PARADOXOS'TOMA, Fischer.—One of the *Cytheridæ*. Valves thin, smooth, elongate, compressed, and subovate, or subtriangular. Its peculiar mouth is simple, tubiform; organs of mastication feeble. It has five joints in the lower and six in the upper antennæ, which last are very slender. Marine. 13 British species. *P. variabile* is very common, and, with others, is fossil in raised beaches &c.

BIBL. Brady, *Tr. Linn. Soc.* xxvi. 456.

PARAME'CIUM, Hill, Ehr.—A genus of Infusoria, of the family Colpodina.

Char. Body covered with cilia; no eye-spot; a papilliform tongue-like process

present; mouth lateral and without projecting cirri.

Ehrenberg describes eight species, two being doubtful.

P. aurelia (Pl. 24. figs. 56 and 57). Body cylindrical, ovate-oblong, rounded or obtuse at the ends, with an oblique longitudinal fold extending to the mouth. Length 1-120 to 1-100″.

This common infusorium shows well the curious star-shaped contractile vesicles. Ehrenberg notices in it the periodical occurrence of small black crystalline particles at the anterior end. The depressions on the surface of the integument (Pl. 25. fig. 1) are distinctly seen in the dried animal.

P. chrysalis, E. (*Pleuronema crassum*, D.) (Pl. 25. fig. 37, undergoing division). Body oblong, cylindrical; oral cilia very long. Length 1-240″.

Bibl. Ehr. *Infus.* p. 349; Duj. *Infus.* p. 481; Stein, *Infus.* passim; Claparède et Lachmann, *Etudes*, 265.

PARAPH'YSES.—The name applied to more or less delicate-jointed, hair-like filaments which occur in small numbers around and between the antheridia and archegonia of Mosses and Hepaticæ (fig. 23, p. 55, fig. 327, p. 375). The same term is applied to simple tubular, more or less clavate cells, occurring in large numbers among the spore-sacs (*asci* and *thecæ*) of the Ascomycetous Fungi and the Lichens (fig. 40, p. 75, fig. 398, p. 452, Pl. 29. figs. 6, 12).

PARASITES.—Under this head are to be included a number of animals and plants infesting other animals and plants, and often nourished at the expense of their structures or juices. Almost every animal and plant is subject to parasites; and they belong to many of the classes of the animal and to a few of the vegetable kingdom. The parasite may live on the surface of its host or within its tissues and in the cavities of its organs; hence the division of the parasitic animals into epizoa and entozoa. But a true parasite must remain in contact with its host during a definite part or the whole of its life-cycle; for an animal which simply attacks, wounds, and feeds upon the juices of its prey, and subsequently makes off, is hardly within the denomination. Some parasites which rest upon their host are hardly worthy of the name; for they fix themselves and derive nourishment from the effects of its locomotion, or from the results of the movement of its organs. For instance, many Infusoria fix themselves on small Crustacea, and are carried here and there, so that their bodies are brought into contact with a much greater supply of food than would have been the case had they been attached to a stationary object. A sea-anemone attaches itself to the carapace of a crab; and although it obtains no nourishment at the expense of its carrier, it still is placed at a great advantage. A similar group of parasites live in and about moving creatures, using them as a house, but not necessarily consuming any of the nourishment of their unwilling protector—for instance, the Crustacea which reside in the Acalephæ. A more important series live in and about the surface and cavities of other animals, and participate in the nourishment or food of the host; and some do little or no harm, whilst others seriously interfere with the nutrition of their victim. The commonest parasites, however, either feed upon the useless external skin tissues, or increase in size and are nourished at the expense of the fluids and blood. In some remarkable instances, as in the cirripeds, the male appears to live parasitically upon the female; and in almost every case of parasitism there is a complicated life-cycle, accompanied by strange adaptations and degenerations of form, so that frequently the effective parasite but slightly resembles its free and youthful form. Animals are subject to parasites at all stages of their existence. Fungi and the eggs of small Hymenoptera are found within the eggs of insects. The larvæ and young of all animals are infested; and so are the adults. Every species may be said to have its parasitic fauna and flora; and every parasite is fashioned so as to preserve its life and perpetuate its species. Hence the minute structures of parasites are of singular variety, and of great interest to the microscopist. There are some wonderful instances of mimicry in the structures of parasites; and they may resemble portions of their host in texture and in colour. The Protozoa afford parasites, especially the Gregarinida and Spongida. The Cœlenterata are rarely parasitic, and probably never in the true sense; but the boring Mollusca, and especially those which affect the corals, must be classified amongst them. The Annelida (Annulata), Scolecida, Crustacea, Arachnida, and Insecta afford the most numerous series. See the classes. Of the animal parasites, the chief portion belong to:—the class Crus-

TACEA, order SIPHONOSTOMA; the class ARACHNIDA, family ACARINA; the class Insecta, orders ANOPLURA and STREPSIPTERA; and the class ENTOZOA.

The Plants parasitic on animals chiefly belong to the class of FUNGI, and they are tolerably numerous; but many of the forms which have been described and named are certainly not distinct plants. They will be most conveniently enumerated under the heads of classes of animals infested.

1. *Man and Mammalia.*

On the Skin.—ACHORION *Schœnleinii* and PUCCINIA *favus* (the former probably an earlier stage of the latter), on the hair and in the follicles, in favus. TRICHOPHYTON *tonsurans*, on the hair in plica polonica and favus; this appears to be a *Torula*-like growth, probably not a mature plant. *Tr.? sporuloides*, C. Rob., occurs in plica, and *Tr.? ulcerina*, C. Rob., in the pus of ulcers. *Microsporon Audouinii* occurs in the hair-follicles in porrigo decalvans; *M. mentagrophytes*, on the beard &c.; *M. furfur*, on the skin of the chest &c. in pityriasis versicolor. The occurrence of *Mucor mucedo* on the skin, and of an *Aspergillus* in the external conduit of the ear, must be regarded as accidental.

On the *mucous surfaces or in cavities.*—SARCINA *ventriculi* in the stomach, &c.; *Torula cerevisiæ* (?), ditto. Various species of LEPTOMITUS, which must be regarded as imperfect mycelial growths, found in almost all the cavities of the body. *Oidium albicans*, Ch. R., the fungus of "aphtha," probably a peculiar condition of PENICILLIUM; *Leptothrix buccalis*, a filamentous growth constant in the tartar of the teeth, probably some allied mycelium.

2. *Birds.*

Various species of ASPERGILLUS have been found in the lungs and air-sacs: their introduction would appear to be accidental. In the eggs of the common fowl, DACTYLIUM *oogenum* occurs not unfrequently, sometimes on the membrane of the yolk, sometimes on the outer membrane, just beneath the shell.—SPOROTRICHUM *brunneum*, Schenk, in the white of eggs, converting it into a brownish gelatinous mass.

3. *Reptiles and Fishes.*

On the skin of Tritons, as of Fishes, ACHLYA is frequently extremely developed; other obscure forms are also enumerated by Ch. Robin. The same author describes the PSOROSPERMIÆ of J. Müller as Algæ allied to the Diatomaceæ; but they appear to be pseudo-naviculæ of GREGARINA.

Mr. Berkeley has recorded the occurrence in Denbighshire, on the scales of goldfish, of a lichen identical with one which is found on stones in neighbouring streams.

4. *Insects*

are subject to the invasion of various parasitic fungi, among the most remarkable of which is the Muscardine of the Silk-worm, BOTRYTIS *bassiana*, which sometimes occasions enormous loss to the silk-cultivators. This fungus grows in or upon any part of the silk-worm, *Bombyx mori*, in its larva, chrysalis, and imago forms. It is not fully developed until after the death of the insect; but if the spores penetrate the body of a living specimen and this is placed in a damp and confined atmosphere, the germination takes place, and a development of the fungus ensues, which destroys the tissues and organs, finally causing death. It has been developed on many other Lepidoptera which have been inoculated with it; and even the larvæ of certain Coleoptera take it. It is very common to find flies in autumn infested with a fungus, a kind of muscardine of flies: this belongs to the genus SPORENDONEMA; its mycelial filaments ramify in the interior of the body, and emerge at the articulations of the segments of the abdomen to bear fruit, killing the fly. A number of so-called genera of Fungi and Algæ have been described by Robin and Leidy as occurring in the intestines &c. of insects; these appear to us to be imperfect organisms (see ECCRINA, ENTEROBRYUS, ARTHROMITUS, LEPTOTHRIX, CLADOPHYTUM). Several species of *Cordiceps* infest the larvæ of insects, the mycelium destroying them and gradually completely displacing the internal organs, while the skin retains its shape and dries; the fruit subsequently breaks out from the anterior or posterior extremity (see SPHÆRIA). Some species of ISARIA, described as parasites, grow upon dead insects; but these are mere conditions of different species of *Cordiceps*.

5. *The microscopic parasites of Plants*

are very numerous, belonging all to the class of Fungi. Much confusion exists in many works between the true parasites and mere epiphytes; and it is sometimes very difficult to draw any line of demarcation. Among

the undoubted parasites are all the genera and species of the family Uredinei, together with a large portion of the other genera of Coniomycetes, and the Ascomycetous forms to which they mostly belong. Among the Hyphomycetes may especially be cited the genus Peronospora, *P. infestans* being the potato-fungus. Fusisporium, "Oidium," &c. form destructive mildews; and among the Ascomycetes the Erysiphæ, and especially their mycelia (commonly forming spurious *Oidia*), are well-known pests. Further particulars are given under Potato-Fungus (*Botrytis infestans*), Vine-Fungus, and Blight. The organisms described as Unicellular Algæ, under the names of Chytridium and *Pythium*, are parasitic on Confervoids.

Bibl. Ch. Rob. *Hist. Nat. des Végét. Parasit.* Paris, 1853; Bærensprung, *Ann. Nat. Hist.* xii.; Siebold, *Wagner's Hand. d. Phys.*; Hannover, *Müller's Archiv*, 1842; Bennett, *Ed. Phil. Trans.* xv.; Küchenmeister, *Parasiten*, 1856; Archer, *Qu. Mic. Jn.* 1872, p. 366; Cobbold, *Entoz.*; Leuckart, *Die mensch. Parasit.* 1867; Murie, *Mo. Mic. Jn.* 1872; Maddox, *Mic. Trans.* 1866.

PARASITIC FUNGI. See Parasites.

PAREN'CHYMA. See Tissues, Vegetable.

PARKE'RIA, Carpenter. — A large spheroidal arenaceous Foraminifer, attaining 3 inches and more in diameter, and consisting of a chambered conical centre-piece (primordial chamber-cone) surrounded by numerous concentric lamellæ and their interspaces, traversed and connected by radial tubes, all of cancellated (labyrinthic) structure. Fossil in the Greensand.

Bibl. Carpenter, *Phil. Trans.* 1869, 721.

PARKE'RIA, Hooker. — The typical genus of Parkerieous Ferns. Aquatic; exotic.

PARKERIE'Æ.—A family of Polypodiaceous Ferns, consisting of aquatic forms, in which the sporanges are not gathered in sori, and the habit is very different from the majority of Ferns.

Genera.

1. *Ceratopteris.* Sporanges surrounded by a broad, complete, articulated annulus, placed upon longitudinal veins. Spores globose, trifariously streaked.

2. *Parkeria.* Sporanges with an almost obsolete basilar annulus, placed on longitudinal veins. Spores three-sided, concentrically streaked.

PARME'LIA, Ach.—An extensive genus of Parmeliaceæ (Gymnocarpous Lichens), characterized by their spreading, lobed, foliaceous thallus, with orbicular apothecia fixed by a central point beneath, growing upon trees, palings, rocks, stones, walls, &c. About thirty British species exist. *P. parietina*, the yellow wall-lichen, is one of the commonest plants of this family, and furnishes a ready means of observing the structure both of the apothecia and the spermogonia (Pl. 29. figs. 1–3).

Bibl. Hook. *Brit. Fl.* ii. pt. 1. p. 202; *Engl. Bot.* pl. 194 &c.; Schærer, *Enum. Crit. Lich. Europ.* (Berne, 1850), p. 33; Tulasne, *Ann. des Sc. Nat.* 3 sér. xvii. pp. 66, 137; Leighton, *Brit. Lich. Flora.*

PARMELIA'CEÆ.—A family of Gymnocarpous or open-fruited Lichens, bearing sessile shields, the borders of which are formed by the surface of the thallus. This family corresponds nearly to the series Ramalodei, Phyllodei, and Placodei, of the family Lichenacei in Leighton's *Brit. Lich. Flora.*

British Genera.

* *Apothecia at first veiled, thallus horizontal*: Peltigeri.

1. *Peltigera.* *Thallus* foliaceous, leathery or membranous, spreading, lobed, with woolly veins beneath. *Apothecia* somewhat circular, adnate on the upper side of the lobules of the thallus, and having a border formed by this.

2. *Nephroma.* *Thallus* foliaceous, leathery or membranous, spreading, lobed, naked or hairy beneath. *Apothecia* circular or reniform, adnate on the under side of the lobules of the thallus, with a border formed by the latter.

3. *Solorina.* *Thallus* leathery, membranaceous, veined or fibrillose below. *Apothecium* suborbicular, affixed to the upper surface of the central lobes of the thallus; veil finally forming an evanescent margin.

** *Apothecia at first closed, thallus horizontal*: Euparmeliacei.

4. *Sticta.* *Thallus* foliaceous, leathery-cartilaginous, spreading, lobed, free and downy beneath, with little cavities or hollow spots, often containing a powdery substance. *Apothecia* beneath formed of the thallus, to which they are appressed and fixed by a central point, the disk coloured, flat, surrounded by an elevated border formed of the thallus.

5. *Parmelia. Thallus* foliaceous, membranous or leathery, spreading, lobed and stellated or laciniated, more or less fibrous beneath. *Apothecia* circular, formed by the thallus, fixed by a central point, disk concave, coloured, with an inflexed margin from the thallus.

6. *Urceolaria. Thallus* uniform, crustaceous. *Apothecia* urceolate, somewhat immersed, the thalline border somewhat distinct.

7. *Lecanora. Thallus* crustaceous, spreading, flat, adnate and uniform. *Apothecia* circular, thick, sessile and adnate; disk plano-convex, the border thickish, formed of the crust, and of the same colour.

8. *Physcia. Thallus* cartilaginous, branched and laciniated, the segments free, generally grooved beneath, the margins frequently ciliated. *Apothecia* circular, peltate, formed of the thallus, the disk coloured and surrounded by an inflexed margin derived from the thallus.

*** *Apothecia open from the first, thallus mostly centripetal, vertical or sarmentose, without any hypothallus,* Usnei.

9. *Cetraria. Thallus* foliaceous, cartilagineo-membranous, ascending or spreading, lobed and laciniated, smooth and naked on both sides. *Apothecia* circular, obliquely adnate to the margin of the thallus, the lower portion being free (from the thallus); disk coloured, plano-concave, with an inflexed border formed of the thallus.

10. *Roccella. Thallus* cartilaginous, leathery, rounded or flat, branched or laciniated. *Apothecia* circular, adnate to the thallus, the disk coloured, plano-convex, with a border, at length thickened and elevated, formed of the thallus, and covering a black powder concealed within the substance of the thallus.

11. *Ramalina. Thallus* cartilaginous, generally branched and laciniated, somewhat shrubby, generally bearing powdery warts, cottony and compact within. *Apothecia* circular, shield-shaped, stalked and peltate, flat, bordered, entirely formed of the substance of the thallus, and mostly of the same colour.

12. *Cornicularia. Thallus* cartilaginous, branched, subcylindrical, fistulose, or nearly solid and cottony within. *Apothecia* circular, terminal, obliquely peltate, entirely formed of the substance of the thallus, at length convex, more or less bordered and often toothed.

13. *Evernia. Thallus* somewhat crustaceous, branched and laciniated, angled or compressed, cottony within. *Apothecia* circular, shield-shaped, sessile, with the disk concave, coloured, and an inflexed border formed by the thallus.

14. *Usnea. Thallus* somewhat crustaceous, rounded, branched, generally pendulous, with a central thread. *Apothecia* circular, terminal on processes of the thallus, peltate, nearly of the same colour, mostly without a raised border, but ciliated at the margins.

Bibl. See the genera.

PASTE, Eels in. See Anguillula.

PATELLI'NA, Will.—A genus of hyaline Foraminifera, of the Rotaline family.

Trochoid, formed of a low cone of subspiral, semiannular, and annular chambers, divided into chamberlets. Sometimes incrusted with small cells externally, and always having the hollow face coated or filled up with superimposed chamberlets, forming a columnar chamber-structure.

British species, *P. corrugata* (Pl. 44. fig. 8), rare: abundant in tropical seas; and of larger size in some Cretaceous and Tertiary strata.

Bibl. Williamson, *Rec. For.* 46; Carter (*Conulites* and *Orbitolina*), *Ann. N. H.* 3. viii. 331, 457, 459; Carpenter, *Introd. For.* 299.

PAVO'NIA, D'Orb.—A porcellaneous Foraminifer, compressed and flabelliform, chambers concentric, the last widest, with numerous marginal apertures. This may be a modified *Orbitolites* or *Orbiculina.*

Madagascar, rare.

Bibl. D'Orbigny, *Ann. Sc. Nat.* vii. 280.

PAXIL'LUS, Fr.—A genus of Agaricini (Hymenomycetous Fungi) with the margin of the pileus involute, the gills decurrent, anastomosing, and separable from the pileus and without any trama. *Paxillus involutus* is a very common species; and to this the characters of the genus more especially apply. *P. pannoides* occurs on sawdust in cellars &c., and is closely allied to *Merulius.*

Bibl. Fr. *Gen. Hym.* p. 8; Berk. *Outl.* t. 12. fig. 5; Cooke, *Handb.* p. 194.

PEARLS.—These well-known bodies are formed as secretions from the mantle of bivalve mollusks, the best being obtained from the Ceylon pearl-oyster or mussel (*Avicula margaritifera*). They occur naturally from the irritation produced by particles of sand accidentally confined between the mantle and the shell; and they are produced

artificially by wounding the mantle with pieces of iron wire, &c. Their structure agrees with that of the shell of the animal in which they are formed. Sometimes they consist entirely of nacre or pearly matter, arranged in close concentric layers; at others, the interior exhibits the prismatic structure of shell.

When acted upon by a dilute mineral acid, the lime-salt is removed from the organic cast of the original, which is left.

See SHELL.

BIBL. Hague and Siebold, *Siebold & Kölliker's Journ.* viii. 439 & 445; Carpenter, *Microscope.*

PEB'RINE is the name of a disease which for the past twenty years has raged amongst the silkworms in France. In 1853, the weight of cocoons produced in that country was 26,000,000 of kilogrammes; in 1865 it had fallen to 4,000,000. The black spots which cover the larvæ are a frequent outward sign of the disease; hence the name *pébrine*, first applied to the plague by M. de Quatrefages. "It also declares itself in the stunted and unequal growth of the worms, in the languor of their movements, in their fastidiousness as regards food, and in their premature death." The cause of the disease is the presence in the internal economy of the larva of corpuscular bodies, considered by Leydig to be organisms belonging to the *Gregarinida.* Their number is often enormous. They take possession of the intestinal canal, and spread thence through the rest of the body. In particular the silk-secreting organs, instead of being filled with the clear viscous liquid of the silk, are packed to distention by these corpuscles. Pasteur in 1865 made out the fact that they might exist in an incipient condition in the eggs and larvæ, although it might be impossible to detect them. In the moths, if either egg or larva from which they come should have been at all stricken, the corpuscles infallibly appear, and there is no difficulty in detecting them. In eradicating the disease, Pasteur, therefore, showed that it was of the greatest importance to secure eggs from healthy moths, since the healthy appearance of the eggs themselves was not sufficient to secure immunity. The larvæ issuing from the eggs of perfectly healthy moths may themselves become infected through contact with diseased larvæ, or through germs mixed with the dust of the rooms in which the silkworms are fed.

BIBL. Pasteur, *Sur la maladie des vers à soie*, and a review of this book by Prof. Tyndall in *Nature*, July 7, 1870; Pasteur, *Mo. Mic. Jn.* 1871, p. 107; Balbiani, *Jour. del. Anat.* 1866, p. 599.

PECTINATEL'LA, Leidy.—A genus of aquatic Polyzoa, of the order Hippocrepia, and family Plumatellidæ.

Char. Polypidom massive, gelatinous, fixed, investing; orifices arranged in irregular lobate areolæ upon the free surface; ova lenticular, with a ring and marginal spines.

P. magnifica. Philadelphia. Not yet found in Britain.

BIBL. Leidy, *Proc. Acad. Philadelphia*, 1851; Allman, *Freshwater Polyzoa*, 81.

PEDA'LION, Hudson.—A genus of Rotatoria, family Hydatinæa.

Char. There are six hollow limbs moved by contained pairs of opposing muscles; and the limbs are three dorsal, two lateral, and one ventral, and all terminate in pairs of stiff imbricated bristles. Pincers absent on the posterior portion of the body; and there are two symmetrically placed ciliated and solid projections somewhat like the tubes of Aphides. *P. mirum*, found and described by Dr. Hudson in 1871, has the trochal disk very large, and resembles, as do the eyes, pharynx, mastax, and stomach, those of *Triorthra longiseta.* The muscles of the limbs and round the body are coarsely striated; and it has at least two vibratile tags on either side, with the usual convoluted tubes; but the contractile vesicle is very small, and has not been seen. The males are very small, and are deficient in most of the internal organs. Habitat. Clifton, fresh water.

BIBL. Hudson, *Mo. Mic. Jn.* Sept. 1871, Nov. 1872; *Qu. Mic. Jn.* Oct. 1872, p. 333; E. Ray Lankester, *Qu. Mic. Jn.* 1872, p. 338.

PEDIAS'TRUM, Meyen.—A genus of Desmidiaceæ (Confervoid Algæ).

Char. Cells aggregated into a usually circular, minute disk or flattened star, and generally arranged either in a single or in two or more concentric series; marginal cells bipartite on the outside.

Ralfs describes eleven British species. Interstices of the cells usually hyaline, but in one species (*P. selenæum*) these are greenish.

A. Braun divided the genera into four subgenera, which include twenty-nine forms more or less worthy of being considered genera.

P. Boryanum (Pl. 10. fig. 48). Cells arranged in one or more circles around one or two central ones; marginal cells gradually tapering into two long subulate points; notch narrow. Diameter of outer cells 1-2730 to 1-2220″.

P. granulatum (Pl. 10. fig. 49). Cells six, granular or punctate on the surface; lobes of marginal cells tapering. Diameter of outer cells 1-1850″.

The method of reproduction is noticed under DESMIDIACEÆ, p. 233.

BIBL. Ralfs, *Brit. Desmid.* p. 180; Al. Braun, *Rejuvenescence, &c. Ray Soc. Vol.* 1853, passim, pls. 3 & 4; *Alg. Unicell. Gen. Nova*, p. 64; Rabenht. *Fl. Euro. Alg.* iii. p. 69.

PEDICELLA'RIÆ. See ECHINODERMATA.

Pl. 37. fig. 3 represents a pedicellaria from the common starfish; the stalk is not figured.

The bird's-head processes of the polyzoa (POLYZOA) are analogous organs.

PEDICELLI'NA, Sars.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Pedicellinidæ.

Char. Those of the family. See PEDICELLINIDÆ (CTENOSTOMATA).

The late researches of Prof. Allman have shown that the tentacular disk is bilateral, and that an epistome is present; so that this genus belongs properly to the order Hippocrepia.

Animal bodies globose, with an interrupted circle of short tentacles, curled inwards and not retractile; placed at the ends of erect slender stalks springing from a creeping adherent fibre.

BIBL. Johnston, *Brit. Zooph.* 381, and the Bibl. therein; Allman, *Freshwater Polyzoa* (*Ray Soc.*), p. 19, note.

PEDICELLIN'IDÆ.—A family of Infundibulate Ctenostomatous Polyzoa, containing the single genus PEDICELLINA.

PEDIC'ULUS, L.—A genus of Anoplurous Insects, of the family Pediculidæ.

Char. Legs all scansorial or prehensile; thorax large, not constricted from the abdomen; abdomen with seven segments; antennæ five-jointed; mouth with a fleshy rostrum.

The species are human lice.

Rostrum retractile, concealed beneath the head, forming a soft tubular sheath dilated at the end, where it is furnished with a double row of hooks, and containing a horny tube formed of four setæ.

1. *P. capitis.* Ashy-white, thorax elongated, quadrate, abdomen ovate, laterally lobed, segments blackish at the margin. Length of male, 1-16″; of female, 1-8″.

2. *P. vestimenti*, body or clothes' louse (Pl. 28. fig. 3). Dirty white, elongato-ovate; head much produced; thorax contracted in front; abdomen with the segments indistinctly indicated. Length about 1-8″.

3. *P. tabescentium*, distemper-louse. Pale yellow; head rounded; antennæ long; thorax large and quadrate; abdomen large, the segments intimately united.

Doubtfully British.

See PHTHIRIUS.

BIBL. Denny, *Anoplur. Monogr.*; Murray, *Ann. Nat. Hist.* 1861, viii. 79; Schjödte, *Ann. Nat. Hist.* 1866, xvii. p. 213.

PELARGO'NIUM. See POLLEN, RAPHIDES, and HAIRS.

PELEC'IDA, Duj.—A genus of Infusoria, of the family of Trichodina, properly LOXODES.

P. rostrum (Pl. 24. fig. 39) = *Loxodes rostrum*, E., differs from the *Paramecia*, D., by the absence of a contractile integument.

BIBL. Dujardin, *Infus.* p. 403; Clap. et Lach. *Etudes*, p. 344.

PEL'LIA.—A genus of Pellieæ (frondose Hepaticæ). *P. epiphylla* (fig. 556) is not

Fig. 556.

Pellia epiphylla.
Magnified 2 diameters.

uncommon in damp shady places, by springs and wells, where it grows rapidly. Its

pedicels are silvery-white, and the capsules pale brown; and when the valves are fully expanded, the elaters form an elegant tuft in the middle. The character of the frond varies somewhat according to the degree of moisture of the habitat. The forms called *longifolia* and *furcigera* are now considered to constitute a distinct species, *P. calycina.*

BIBL. Hooker, *Brit. Jung.* pl. 47; *Brit. Flora*, ii. pt. 1. p. 130; Endlicher, *Gen. Plant. Supp.* i. No. 472–5; Ekart, *Syn. Jung.* p. 63, pls. 7 & 13; *Eng. Bot. Supp.* pl. 2873.

PELLIE'Æ.—A tribe of Liverworts or Hepaticæ, nearly allied to the Jungermannieæ in the character of the fructification, but having a lobed thalloid frond, traversed by a mid nerve, from which the fruit-stalks arise.

British Genera.

1. *Blyttia.* Fructification emerging from the end of the rib below the apex of the frond, at length dorsal. Perichæte 4–5-parted; lobes torn. Perigone herbaceous, tubular, the mouth denticulated. Archegones eight to twenty. Epigone persistent, torn at the summit. Sporange 4-valved. Antheridia dorsal, placed on the rib, covered by dentate incumbent leaflets.

2. *Petalophyllum.* Fructification from the upper surface of the plaited frond. Perichæte broad, bell-shaped and toothed. Perigone wanting. Epigone concealed in the perichæte. Sporange bursting into irregular laciniæ. Elaters often branched.

3. *Fossombronia.* Fructification emerging from the end of the rib below the apex of the frond, at length dorsal. Perichæte obconic bell-shaped, the mouth crenate or dentate. Perigone wanting. Archegones few. Epigone persistent, torn at the summit. Sporange circumscissile. Antheridia dorsal, situated on the rib, naked.

4. *Metzgeria.* Fructification emerging from the ventral side of the midrib of the frond. Perichæte ventricose, at length bipartite. Perigone none. Archegones few. Epigone persistent, torn at the summit. Sporange four-valved. Antheridia ventral, placed on the rib, covered by incumbent dentate leaflets.

5. *Aneura.* Fructification emerging from the ventral side, near the margin of the frond. Perichæte short, lobed or torn. Perigone wanting. Archegones few. Epigone persistent, torn at the summit. Sporange four-valved. Antheridia immersed in the back of special lobes of the frond.

6. *Pellia.* Fructification emerging from the dorsal side of the frond. Perichæte short, somewhat cup-shaped, the mouth lacero-dentate. Perigone wanting. Archegones several. Epigone membranous, accompanied by a few sterile archegones, at first, at the lower part. Sporange four-valved. Antheridia immersed in the surface of the frond.

7. *Blasia.* Fructification at first immersed in the rib of the frond, then emerging from the apex. Perichæte and perigone wanting. Epigone membranous, with few sterile archegones, at first, scattered toward the lowest part. Sporange four-valved. Antheridia immersed in the rib of the thallus, more prominent below, and covered by little dentate scales.

8. *Targionia.* Fructification sessile, inferior, solitary and terminal to the frond. Perichæte two-valved, splitting vertically. Perigone wanting. Epigone delicate, persistent, investing the sporange until maturity, sometimes evanescent above. Sporange bursting by an irregular slit, or into fragments. Antheridia immersed in the rib of the frond below, covered by papillæ.

BIBL. See the genera, and HEPATICÆ.

PELOMYX'A, Greef (Syn. PELOBIUS, Greef).—A genus of Amœbina.

This freshwater organism forms large amœboid masses of brown colour, which protrude lobose hyaline pseudopodia. The ground-substance contains nuclei, hyaline homogeneous highly refractive bodies, and delicate rod-like bodies. It gives rise to swarms of minute Amœbæ, which become developed into flagellate freely-swimming organisms.

Greef regards *Pelomyxa* as a multicellular or, rather, multinuclear amœboid organism allied to the Myxomycetes, but to be classed with the Rhizopoda.

BIBL. Greef, *Max Schultze's Archiv Mik. Anat.* 1873; *Qu. Mic. Jn.* 1874, p. 97.

PELONÆ'A, Forbes.—A genus of Tunicate Mollusca, of the family Pelonæadæ.

Char. Unattached; feet cylindrical; orifices without rays, on two equal approximate warty eminences at the anterior end. They live buried in mud. Two species:

1. *P. corrugata.* Test deep brown, much elongated, rudely wrinkled transversely.

2. *P. glabra.* Test greenish yellow, smooth, pilose, shorter than the last. See TUNICATA.

BIBL. Forbes and Hanley, *Brit. Moll.* i. 43.

PE'LOPS, Koch (*Acarina*).—Is consolidated with GALUMNA.

PELTIDE'A, Hoffm.=Species of PELTIGERA and STICTA.

PELTIG'ERA, Willd. — A genus of Parmeliaceæ (Gymnocarpous Lichens), characterized by a foliaceous, usually leathery thallus, with woolly veins beneath, the suborbicular shield-like apothecia arising on the upper sides of the lobules.

P. canina, a large Lichen, is extremely common on the ground among moss in woods. Two or three nearly allied species are separated from this by most authors, but with questionable propriety. Three or four others are subalpine.

BIBL. Hook. *Brit. Flora*, ii. pt. 1. p. 218; *Eng. Bot.* 2229; Leighton, *Brit. Lich. Flor.* p. 167.

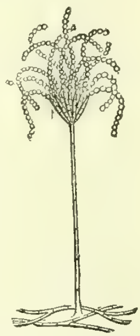
PENEROP'LIS, Lamk.— A genus of porcellaneous Foraminifera.

Broad, complanate, and ear-shaped (*P. pertusus*, Pl. 18. fig. 11), or narrow, subcylindric, and crosier-like (*Spirolina*) (*S. austriaca*, Pl. 18. fig. 12); striated. The primordial double chamber is succeeded by curved chambers in one direction; and as these vary in transverse extent, sometimes to even three fourths of a circle, the shell takes different shapes. The aperture is single and lobulate in the early chambers; cribrate in the narrow, branched in the nautiloid forms (*Dendritina*); and divided into rows of holes, often tubular, in the outspread varieties. Living in the Mediterranean and warm seas only; fossil in the Tertiaries.

BIBL. Williamson, *Rec. For.* 45; Parker and Jones, *Ann. Nat. Hist.* ser. 3. v. 179; Carpenter, *Phil. Trans.* 1859, 2; *Introd. Foram.* 84.

PENICIL'LIUM, Link.—A genus of Mucedines (Hyphomycetous Fungi), of which the species *P. glaucum* is at once one of the most frequent and the most puzzling plants of the class. This fungus is the commonest of the constituents of the greenish or bluish mould formed on decaying vegetable substances of all kinds, especially on semifluid or liquid matters. On the surface of liquids it forms a kind of dense pasty crust, slimy on the lower surface, and coloured and pulverulent (bearing spores) above. When the upper fertile layer is examined under the microscope, it is found to consist of pedicels terminating in a repeatedly but shortly bifurcated pencil, each ultimate branch of which bears a moniliform row of spores. The ramification of the pedicels is not distinctly represented in fig. 557; but the appearance of the spores is characteristic; and the ramifications of the sporophores are scarcely perceptible in examples growing on dryish substances. The mode of attachment of the spores is shown in figs. 15 and 16 of Pl. 20. The mycelium consists of interwoven articulated filaments, most extensively ramified. The spores appear whitish, yellowish, greenish, or bluish, according to age: under the microscope they appear opaque when mature.

Fig. 557.



Penicillium.

A fertile plume with pencils of spores.

Magnified 150 diameters.

So far there is little difficulty about the history of these plants; and if the spores of the above form are sown on a glass slide, kept moist with an organic liquid, they will germinate and ramify, and under favourable circumstances bear thin penicillate tufts of spores at points which emerge from the nutrient liquid. But this same fructification of *P. glaucum* presents itself invariably under certain circumstances associated with the vinegar-plant and the yeast-plant, toward the close of the ordinary development of these fungi. In common with most observers, we find that the exhaustion of the saccharine matrix of the vinegar-plant is followed in all cases by the appearance of crusts of *Penicillium*-mould on the upper surface, whence it would appear that the vinegar-plant was only the mycelium of *Penicillium*. It was asserted, moreover, many years ago, by Turpin, that *P. glaucum* is the last term of the growth both of the true yeast-plant (*Torula Cerevisiæ*) and of the milk-yeast (*Oidium lactis*). We have found the gelatinous crusts of the vinegar-plant to contain structures which represent *Torula* and *Oidium*, and to grow like them; and we have also observed, in repeated experiments, that beer allowed to stand until sour, at first appears clothed with a whitish mealy collection of minute vesicles, representing the ultimate stage of *Torula*, and subsequently this gradually gave place to gelatinous matter, which at length covered the whole surface with a tough film, and fruited as *Penicillium glaucum*. Hence it

would appear that the yeast-fungus also is merely a vegetative form of *Penicillium* developed under peculiar conditions. This, however, has been actually proved by Berkeley and Hoffman (see art. "Yeast," in Black's 'Encyclopedia of Agriculture'). More is said on this point under VINEGAR-PLANT and YEAST.

One of the species has become famous on account of its extremely rapid occurrence in Paris on the "pain de munition," where the spores must have undergone a degree of heat equal to that of boiling water.

Several species are enumerated; and we have given under the separate head of COREMIUM a form which is merely a confluent growth of *Penicillium*, producing a compound pedicel.

1. *P. glaucum*, Grev. Mycelial filaments form a crust-like web, spores green or bluish. Greville, *Sc. Crypt. Fl.* pl. 58. fig. 1. *P. crustaceum*, Fries. Extremely common.

2. *P. candidum*, Link. Mycelial filaments woven together, spores white. (Distinct?)

3. *P. sparsum*, Grev. Mycelium lax, spores white. *Sc. Crypt. Fl.* pl. 58. fig. 2. Perhaps not different from the last.

4. *P. fasciculatum*, Sommer. Mycelium scarcely developed, filaments all fertile, trifid at the apex, spores glaucescent.

5. *P. subtile*, Berk. Extremely minute, mycelium creeping, fertile filaments erect, simple or ternate; chains of spores few, spores broadly elliptical. *Ann. Nat. Hist.* vi. pl. 14. fig. 25.

6. *P. roseum*, Link. Mycelium effused; fertile filaments slightly branched, spores rose-colour.

BIBL. Berk. *Hook. Brit. Flor.* ii. pt. 2. p. 344; *Ann. Nat. Hist.* i. p. 262, vi. p. 437, 2 ser. vii. p. 102; Greville, *loc. cit.*; Fries, *Syst. Myc.* iii. 407; *Summa Veget.* p. 489; Huxley, *Biol. Address, Brit. Assoc.* 1870. See also under YEAST and VINEGAR-PLANT.

PE'NIUM, Bréb.—A genus of Desmidiaceæ.

Char. Cells single, entire, elongated, straight, and slightly or not at all constricted in the middle.

Sporangia round or quadrangular, smooth, not spinous.

At each end of the cells is a rounded space containing moving molecules.

Several British species (Ralfs).

P. Brebissonii (Pl. 10. fig. 36). Cells smooth, cylindrical, ends rounded, transverse median band inconspicuous. Length 1-640 to 1-400″.

Common. Sporangium at first quadrate, but finally orbicular; conjugating cells persistent, or remaining permanently attached to the sporangium.

P. margaritaceum (Pl. 10. fig. 37, empty cell). Cells cylindrical or fusiform, with rounded truncate ends, and covered with pearly granules in longitudinal rows. Length 1-160″.

BIBL. Ralfs, *Brit. Desmid.* p. 148; Archer, *Qu. Mic. Journ.* 1864, p. 179, 1867, p. 183; Hassall, *Fr. Alg.*; Rabenh. *Fl. Eur. Alg.* iii. p. 119.

PENNAT'ULA, Cuv. (Sea-pen).—A genus of Pennatulidæ, of the order Alcyonaria (Cœlenterata).

The spicula or sclerites form interesting microscopic objects.

BIBL. Johnston, *Brit. Zooph.* 157; Gosse, *Mar. Zool.* i. 34; Milne-Edwards and J. Haime, *Hist. Nat. des Corall.* i. p. 207; Panceri, *Qu. Mic. Jn.* 1872, p. 248.

PEPPER.—Black pepper consists of the berries of *Piper nigrum*; white and decorticated pepper of the same berries, with the outer part of the coats removed. The cellular tissues of the several lamellæ of the husk, and of the albumen or body of the seed, are tolerably characteristic, and may be known by their appearance under the microscope from the fragments of linseed, mustard, &c. with which peppers are sometimes adulterated. White pepper is fraudulently reduced with flour, which may be detected by the starch-granules—those existing in pepper itself being exceedingly minute particles; the same remark applies to rice and pea-flour, &c. Excessive quantities of the husk-tissue in black pepper denote that the refuse of the decorticated white peppers has been added. (See also CAYENNE.)

BIBL. Pereira, *Materia Medica*; Hassall, *Food and its Adulterations*, p. 42.

PERACAN'THA, Baird.—A genus of Entomostraca, of the order Cladocera, and family Lynceidæ.

Char. Side view of shell oval, the lower and posterior portion with an acute projection directed backwards and upwards, and, as well as the upper extremity of the anterior margin, beset with strong hooked spines; beak sharp, curved downwards.

P. truncata (Pl. 14. fig. 31). Superior antennæ conical; inferior short, the anterior branch with five setæ, one from first, one

from second, and three from last joint; posterior branch with three setæ from the last joint only; intestine convoluted, with one turn and a half; ova two. Aquatic.

BIBL. Baird, *Brit. Entom.* p. 136.

PERANE'MA, Duj.—A genus of Infusoria, of the family Euglenia (Flagellata).

Char. Form variable, sometimes nearly globular, at others inflated posteriorly and narrowed in front, where it becomes prolonged into a long flagelliform filament; movement slow, uniform, forwards.

P. globulosa (Pl. 24. fig. 59). Body almost globular, more or less drawn out anteriorly, with oblique wrinkles on the surface; aquatic; length 1-1400".

BIBL. Dujard. *Infus.* p. 353; Pritchard, *Infus.* p. 545.

PERANE'MA, Don = *Sphæropteris*, Br. —A genus of Peranemeæ (Polypodioid Ferns).

PERANEME'Æ.—A family of Polypodioid Ferns characterized by the globose sori being pedunculated or seated on the middle of the superior vein; indusium inferior, membranous, splitting into laciniæ.

Genera.

1. *Peranema.* Sori pedunculate, indusium cup-shaped, at length splitting into 2–4 lobes; sporanges on a punctiform receptacle; veins pinnate.
2. *Diacalpe.* Sori regularly arranged; indusium sessile, spherical, at first closed; sori on a punctiform receptacle, then bursting irregularly at the summit.
3. *Woodsia.* Sori regularly arranged; sporanges pedicillate, inserted at the bottom of the indusium, which is cup-shaped, and hairy at the margin; veins pinnate.
4. *Hypoderris.* Sori regularly arranged; sporanges on an almost obsolete axis; indusium cup-shaped, fringed at the margin; veins anastomosing.

PERFORATA, Carpenter. — The suborder of Foraminifera that possess a vitreous or hyaline shell perforated by tubular openings for the exit of pseudopodia.

BIBL. Carpenter, *Introd. Foram.* 149.

PERICHÆ'NA, Fr.—A genus of Trichogastres (Gasteromycetous Fungi), consisting of little rounded membranous sacs of brownish or yellowish colour, generally splitting all round (transversely), and discharging yellow spores and (few) free and elastic filaments. The commonest (*P. populina*), yellowish and about as large as a mustard-seed, occurs on fallen poplar trees; two others occur in fir-plantations.

BIBL. Berkeley, *Hook. Brit. Fl.* ii. pt. 2. p. 321; Fries, *Syst. Myc.* p. 190; *Summa Veget.* p. 459; Greville, *Sc. Crypt. Flora*, p. 252.

PERICO'NIA, Tode.—A genus of Dematiei (Hyphomycetous Fungi), characterized by a stem composed of fasciculate compacted threads. Head globose; spores fixed on the free apices of the threads. It is analogous to *Pachnocybe.* Tulasne states that it is merely a conidiiferous form of some *Sphæria.* Two species occur in this country.

P. glaucocephala, Cd.; on decayed linen.

P. calicioides, B.; on dead herbaceous stems.

BIBL. Fries, *Summa Veg.* p. 168; Berk. and Broome, *Ann. N. Hist.* 2 ser. v. p. 165; Tulasne, *Ann. des Sc. Nat.* 4 sér. v. p. 109; Cooke, *Handb.* p. 565.

PERIDERM. See BARK.

PERIDER'MIUM, Lk.—A genus of Uredinei (Coniomycetous Fungi), distinguished from ÆCIDIUM by the sac-like perithecium bursting irregularly, as if by a circumscissile dehiscence. The type of this genus is *P. (Æcid.) Pini*, found on the leaves and bark of Scotch Firs. The spores are covered with very numerous small tubercles. See UREDINEI.

BIBL. Berk. *Brit. Flora*, ii. pt. 2. p. 374; Tulasne, *Ann. des Sc. Nat.* 4 sér. ii. p. 176, pl. 10; De Bary, *Brandpilze, Berlin*, 1853, p. 72.

PERIDIN'IUM.—A genus of Peridinina (INFUSORIA cilio-flagellata).

Char. Body with a transverse groove, the two portions of the lorica being nearly equal. No horned prolongation to the cuirasse. It differs from *Ceratium* in this last peculiarity.

Species: 1. *P. tabulatum* = *Glenodinium tabulatum*, Ehr. 2. *P. apiculatum* = *Glenodinium apiculatum*, Ehr. (Pl. 24. fig. 10 *c*). 3. *P. cinctum* = *Glenodinium cinctum*, Ehr. (Pl. 24. fig. 10 *a*, *b*). 4. *P. acuminatum.* 5. *P. reticulatum.* 6. *P. spiniferum.* 7. *P. fuscum*, Ehr. (Pl. 24. fig. 11).

P. tripos, Ehr. (Pl. 24. fig. 12) is a *Ceratium.* Yellowish and splendidly phosphorescent in the sea. Length 1-140". Allman has described *P. uberrimum.*

BIBL. Ehr. *Infus.* p. 262; Duj. *Infus.* p. 374; Allman, *Micr. Jn.* iii. 24; Clap. et Lach. *Etudes*, 403; Clark, *Ann. Nat. Hist.* 1865, xvi. p. 270.

PERIDINI'NA.—An order of Infusoria, comprehending the Cilio-flagellata. See INFUSORIA, pp. 410 and 411, for the description of the group and the synopsis of the genera.

PERIGON'IMUS, Sars. — A genus of Atractylidæ, a family of Hydroida. The species usually colonize the shells and opercula of Mollusca and the shells occupied by the Hermit Crab.

Char. Cœnosarc sheathed in a chitinous polypary; stems branching or simple, rooted by a thread-like stolon; polypites fusiform, with a single verticil of filiform tentacles round the base of a conical proboscis; gonophores developed from the cœnosarc. Gonozooids free and medusiform. Umbrella deep bell-shaped; manubrium short; radial canals 4; marginal tentacles 2 or 4, increasing in number with age, springing from non-ocellated bulbous bases.

BIBL. St. Wright, *Proc. Roy. Soc. Edin.* 1857, 1858; *Ann. Nat. Hist.* 1861, p. 130; Alder, *Supp. Cat. in Trans. Tynes. F. C.* v. p. 230; Allman, *Ann. Nat. Hist.* 1863, 1864; Hincks, *Brit. Hyd. Zooph.* p. 89.

PERI'OLA, Fries.—*P. tomentosa,* Fr., described as a Sclerotioid Fungus, is an obscure, irregular, fleshy body, with a white villous surface, found growing on potatoes. It is probably the early form of some unascertained species of fungus. This was characteristic of those forms of potato-rot which were known before the introduction of the *Peronospora.*

PERIP'TERA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, compressed; valves dissimilar, one being simply turgid, the other winged or furnished with horns; horns sometimes branched and attached to the extreme margin. Fossil.

Valves not areolar nor punctate under ordinary illumination. America and Bermuda.

P. chlamidophora (Pl. 41. fig. 41); *P. tetracladia* (Pl. 43. fig. 66); *P. capra* (Pl. 43. fig. 67).

BIBL. Ehrenb. *Ber. d. Berl. Akad.* 1844, p. 263; Kütz. *Sp. Alg.* p. 25.

PERISPORA'CEI.—A family of Ascomycetous Fungi, mostly epiphytic and of small size, characterized by producing floccose common receptacles (mostly) radiating from a point, forming patches upon leaves, &c., in the centre of which are developed somewhat globular perithecia, of obscure cellular structure, persistent, bursting at the summit, filled densely with subgelatinous, scarcely diffluent gelatine; sporidia produced in asci, subsequently often effused, simple, free, and mixed with the gelatine in the centre of the perithecium. The mycelia of these plants, bearing conidial structures, have been described as distinct fungi, for example those of *Erysiphe* as *Oidia,* &c. See ERYSIPHE. EUROTIUM probably belongs here.

Synopsis of British Genera.

1. *Lasiobotrys.* Perithecium fleshy-horny, globular, naked, collapsing at the summit.

2. *Capnodium.* Perithecium fleshy, clavate, double (the outer cellular, interior hyaline), mucilaginous, opening by a fringed mouth; asci containing about six spores in two rows.

3. *Erysiphe.* Perithecium membranous, closed at first, afterwards open, supported on a persistent radiating mycelium formed of continuous filaments bifid at their ends. Asci one to eight, paraphyses none; spores definite, ovate.

4. *Perisporium.* Perithecium superficial, at length bursting irregularly. Asci club-shaped, not mixed with paraphyses. Spores numerous, ovate.

5. *Chætomium.* Perithecium superficial, finally open at the mouth, clothed externally with opaque hairs. Asci clavate, mixed with paraphyses. Spores simple, ovate.

6. *Ascotricha.* Perithecium thin, at length bursting, clothed with dark, subpellucid, even, obscurely-jointed hairs. Spores simple, contained in linear asci. Superficial, at length free or resting on the investing thallus, black.

7. *Orbicula,* Cooke. Perithecium seated on a distinct mycelium, reticulated. Ostiolum obsolete; sporidia subglobose; paraphyses simple or branched.

PERISPO'RIUM, Fr.—A genus of Perisporacei (Ascomycetous Fungi), consisting of minute, globular, free, punctiform sacs, with fleshy or waxy walls, seated on an obscure thallus, growing on leaves or stalks; finally bursting and collapsing. The spores are produced in large numbers in swollen clavate asci (figs. 558, 559), which are unaccompanied by paraphyses.

BIBL. Fries, *Summa Veg.* p. 404; *Syst. Myc.* iii. p. 248; Berk. *Ann. Nat. Hist.* vi. p. 432.

PERISTEPHA'NIA, Ehr.—A genus of Diatomaceæ, closely allied to Stephano-

discus, differing, however, in having a parallel (and non-radiate) arrangement of the granules; and also to *Systephania*, which differs only in having intramarginal teeth. *P. eutycha* in deep Atlantic soundings; *P. lineata* in guano.

BIBL. Pritchard, *Infus.* p. 824.

PERITHE'CIUM.—The name applied to the special envelope, mostly of different structure from the rest of the thallus or the receptacle, enclosing the "nucleus" of the Angiocarpous Lichens and the Pyrenomycetous Fungi.

PERITH'YRA, Ehr.—A doubtful genus of Diatomaceæ. Probably closely allied to *Coscinodiscus*. 2 species from the Ganges.

BIBL. Pritchard, *Infus.* p. 842.

PERITONE'UM. See SEROUS MEMBRANES.

PERIZO'NIUM, Cohn et Jan.—A genus of Diatomaceæ, family Naviculaceæ.

Char. Frustules naviculate, free, and encircled with thick linear zones.

BIBL. Rabenht. *Fl. Eur. Alg.* i. p. 228.

PERO'NIUM, Cohn.—A genus of Monadina allied to *Anthophysa*. It is parasitic on the spores of *Pilularia*, and consists of a delicate, colourless fibre surmounted by a globular head which resolves into numerous narrow cells of a monadiform character.

BIBL. Cohn, *Entwick.* p. 158; Pritchard, *Infus.* p. 501.

Fig. 558.

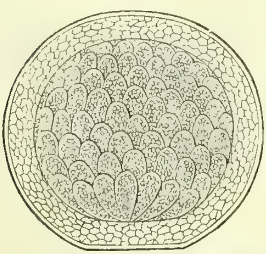
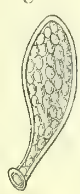


Fig. 559.



Perisporium disseminatum.

Fig. 558. A perithecium in vertical section. Magnified 100 diameters.
Fig. 559. An ascus detached. Magnified 300 diams.

PERONOS'PORA, Ung. See BOTRYTIS.

PEROPH'ORA, Wiegm.—A genus of Tunicate Mollusca, of the family Clavelinidæ.

Char. Individuals stalked, roundish, compressed; thorax not marked with granular lines.

P. Listeri. Occurs attached to sea-weeds. Very transparent, appearing like little specks of jelly dotted with orange and brown.

BIBL. Forbes and Hanley, *Brit. Mollusca*, i. 28.

PERTUSA'RIA, DC.—A genus of Endocarpeæ (Angiocarpous Lichens), having an adnate, uniform thallus, spreading over bark, rocks, &c., and bearing wart-like apothecia, finally exhibiting a depressed pore in their centre, leading to the one or several cells containing the thecæ. *P. communis* is very common on trees.

BIBL. Hook. *Brit. Flor.* ii. pt. 1. p. 164; *Engl. Botany*, pl. 677; Leighton, *Brit. Lich. Flora*, p. 236.

PESTALOZ'ZIA, De Not.—A genus of Melanconiei (Coniomycetous Fungi), with septate spores seated on a long pedicel, and crested at the apex. Three species occur in this country. *P. Guepini* is sometimes very destructive to Camellias. They are beautiful microscopic objects.

See fig. under STYLOSPORES.

BIBL. Berk. *Outl.* p. 324; Cooke, *Handb.* p. 471.

PETALONE'MA, Berk. (*Arthrosiphon*, Kütz.).—A genus of Oscillatoriaceæ (Confervoid Algæ), presenting a very remarkable mode of growth. The filaments are branched and cylindrical, with a very evident terete, gelatinous, duplicate sheath (Pl. 4. fig. 21). The inner is thin and follows the filament; the outer presents oblique striæ indicating the interposition of lengths of the outer sheaths one inside another, like a series of nested funnels or conical cups. This appearance is produced by the bursting and expansion of each length of the sheath at the apex alone, to make room for the growth of the new cells of the filament formed at the apex. This structure is analogous to that occurring in UROCOCCUS, where each parent-cell membrane bursts at one side only to allow the new one to emerge, thus at length forming a jointed pedicel. The edges of the "funnels" of *Petalonema* sometimes become decomposed into curled filamentous processes.

The filament of *P. alatum* is green and striated, about 1-3000″ in diameter; the inner sheath is yellowish, the outer colourless and 1-400″ in diameter. It forms a brownish stratum on rocks and stones.

BIBL. Berkeley, *Gleanings*, p. 23, pl. 7; Greville, *Sc. Crypt. Fl.* pl. 222; Hassall, *Brit. Fr. Alg.* p. 237, pl. 68; Kütz. *Spec. Alg.* p. 311; *Tab. Phyc.* ii. 28; Al. Braun, *Rejuven. &c.*, *Ray Soc. Vol.* 1853, p. 178; Rabenht. *Fl. Eur. Alg.* ii. p. 265.

PETALOPHYL'LUM, Wilson.—A ge-

nus of Pellieæ (frondose Hepaticæ). *P. Ralfsii* is an elegant little Liverwort with the frond plaited or lamellated in rays from the origin of the fruit.

BIBL. *Engl. Bot. Supp.* pl. 2874.

PETAL'OPUS, Clap. et Lach.—A genus of Amœbina, a family of Rhizopoda resembling to a certain extent Actinophryina. Their pseudopodia are filiform, and only start from one point of the surface, as in *Plagiophrys*; but they expand at their end into a delicate film. The film and pseudopodia become globular before retraction within the sarcode of the body. There is one species (German).

BIBL. Claparède et Lachmann, *Etudes*, p. 442.

PETALS.—The petals of Flowering Plants afford many interesting microscopic objects, in the epidermis, glandular and other hairs, the colour-cells and the veins composed of spiral vessels. Entire petals of small size and delicate character form good objects when dried and mounted in Canada balsam. Those of the smaller Caryophyllaceæ, the ligulate corollas of Compositæ, &c., are well suited for this. The larger kinds are studied by means of sections, like LEAVES.

PETRO'BIUS, Leach.—A genus of Insects, of the order Thysanura, and family Lepismenæ.

P. maritimus has a general resemblance to *Lepisma saccharina*; but it exercises a leaping movement. The antennæ are longer than the body; of the setæ at the tail, the middle one is longest. The insect is of a blackish-brown colour, and is covered with scales; the legs are yellowish, and the caudal setæ ringed with white; the abdomen is furnished with gill-like processes.

It is found upon the rocky sea-coast.

The scales have been used as test-objects.

BIBL. Gervais, *Walckenaer's Apt.* iii. p. 447; Guérin, *Iconogr. Ins.* pl. 2. fig. 1*f*; and *Ann. des Sc. Nat.* 2 sér. v. p. 374.

PETRONE'MA, Thwaites.—A genus of Oscillatoriaceæ (Confervoid Algæ). *P. fruticulosa* grows as a frustulose olive-brown crust on limestone rocks (not marine), forming little hemispherical masses; the sheaths are thick and cartilaginous, brown above but colourless at the tips, the protoplasma dull green.

BIBL. *Engl. Bot. Supp.* pl. 2959.

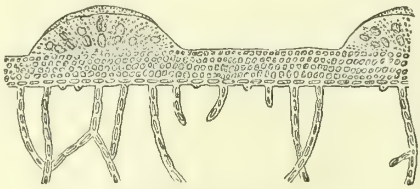
PEYER'S GLANDS. See INTESTINES (p. 428).

PEYSSONE'LIA, Dcne.—A genus of Cryptonemiaceæ (Florideous Algæ), consisting of small plants with a depressed lobed thallus (fig. 560), growing over stones, shells, &c., and attached by the whole under surface, which produces jointed radical hairs (fig. 561), especially at the thin margins. The thallus is composed of several rows of compact parenchymatous cells, and bears, on the concentrically-marked surface, warts composed of radiating rows of cells, among which occur crucially-divided *tetraspores*. *P. Dubyi* is not uncommon on British shores; it is 1 to 2″ in diameter, roundish at first, ultimately irregularly lobed, colour dull brownish. Thuret has observed *antheridia* on distinct plants of *P. squamosa*, a Mediterranean form; they are jointed filaments collected into wart-like bodies, like those containing the tetraspores. The spores are not described.

Fig. 560.

Thallus. Nat. size.

Fig. 561.



Peyssonelia squamosa.
Vertical section of a portion through two warts.
Magnified 25 diameters.

BIBL. Harvey, *Brit. Mar. Alg.* p. 144, pl. 14 D; *Phyc. Brit.* pl. 71; Thuret, *Ann. des Sc. Nat.* 4 sér. iii. p. 23, pl. 4.

PEZI'ZA, Dill.—A genus of Helvellacei (Ascomycetous Fungi), containing numerous species, a large number of which grow upon dead wood, on the ground, among leaves, &c., many brightly coloured. They are at first closed sacs, which burst at the summit, and spread out to form a kind of cup containing asci and paraphyses. Thus they belong to the Discomycetes of some authors.

Tulasne has recently shown that some of the *Pezizæ* have a secondary fructification consisting of *stylospores*; these forms have been described as species of *Dacrymyces*, a genus of Tremellini. Other species also produce *spermatia*: but this was long since suspected by Fries.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 186; Fries, *Summa Veg.* p. 348; Tulasne, *Ann. des Sc. Nat.* 3 sér. xx. p. 167; Currey, *Quart. Journ. Mic. Sc.* v. p. 124.

PHACELOM'ONAS, Ehr.—A doubtful genus of Infusoria.

Char. Tail-like process absent; a red (eye-) spot present; mouth terminal, truncate, furnished with eight to ten anterior long cilia or flagelliform filaments, vacuoles numerous.

P. pulvisculus. Body oblong, subconical, attenuate posteriorly, bright green; aquatic; length 1-1150″. Occurs in myriads in pools. Perhaps zoospores of ŒDOGONIUM.

BIBL. Ehr. *Infus.* p. 28; Pritch. *Infus.* p. 494.

PHACIDIA'CEI.—A family of small Ascomycetous Fungi, mostly growing in large numbers on the half-decayed woody parts of plants, or on the ground; consisting usually of dark-coloured indurated or leathery bodies, solitary or connate, or seated on a common base, closed at first and containing a soft nucleus; the outer case (*perithecium*) subsequently opening widely, and presenting a cavity lined with asci containing spores.

The history of development of these plants is still obscure; for many of them are connected with certain of the Coniomycetes as different stages of one and the same plant. We describe the genera according to the existing classifications, noting the new facts relating to these metamorphic phenomena in the articles on the particular genera.

British Genera.

* *Perithecium open, margined, closed by a lid or veil.*

1. *Patellaria.* Perithecium patelliform, margined, open, covered with a thin veil confluent with the nucleus. Disk at length pulverulent, the annulate asci breaking out.

2. *Tympanis.* Perithecium cup-shaped, margined, open, covered by a thin, evanescent veil. Disk fixed in the receptacle (*proper stratum*), at length dissolved. Asci filiform, fixed.

** *Perithecium (excipulum) at length open, connate with the floccose receptacle. Nucleus discoid, ascigerous, placed on the receptacle.*

3. *Cenangium.* Perithecium entire, leathery-horny, opening by a connivent mouth, distinct from the discigerous stratum. Asci filiform, persistent, expelling the separate spores with violence.

*** *Perithecium entire, dehiscing by closely connivent slits.*

4. *Lophium.* Perithecium subsessile, elongated, compressed, bursting by a longitudinal slit. Asci erect, fixed, cylindrical, persistent; sporidia simple, rounded. Thallus crustaceous or imperceptible.

**** *Perithecium somewhat dimidiate, at length open, nucleus naked.*

5. *Rhytisma.* Perithecium innate, of irregular form, opening by fragments breaking off into a flexuous slit; nucleus placentiform, persistent. Asci erect, fixed; paraphyses stalked.

6. *Phacidium.* Perithecium roundish, simple, bursting with several teeth at the summit; nucleus disk-shaped, in some degree persistent. Asci erect, fixed; paraphyses stalked.

7. *Hysterium.* Perithecium sessile, oval or elongated, with a longitudinal slit at first closed, afterwards gaping open; nucleus linear, somewhat persistent. Asci erect, fixed; paraphyses stalked.

8. *Labrella.* Perithecium innate, bursting by a longitudinal slit; asci short, broad and obtuse above, attenuated below, mixed with short flexuous paraphyses; spores few, ovate-oblong, occasionally contracted or septate in the middle.

PHACID'IUM, Fr.—A genus of Phacidiacei (Ascomycetous Fungi), containing many species growing on dead leaves, branches, &c. Some of them are common, as *P. dentatum*, on oak-leaves.

BIBL. Berk. *Brit. Fl.* ii. pt. 2. p. 291.

PHACOP'SIS, Tul.—A genus of Micro-lichens, parasitic on the thallus of *Everniæ* and *Lecanoræ*.

BIBL. Linds. *Hist. Brit. Lich.* p. 318; *Qu. Mic. Jn.* 1869, p. 143.

PHACO'TUS, Perty.—A genus of Cryptomonadina.

Char. Body round, biconvex, with two or four filaments. Probably it is one of the Algæ.

BIBL. Pritchard, *Infus.* 513.

PHA'CUS, Nitzsch., Duj.—A genus of Infusoria, of the family Thecamonadina, D. (Cryptomonadina, E.).

Char. Body flattened and leaf-like, usually green, with an anterior red (eye-) spot, a single flagelliform filament, and covered with a resisting membranous integument, prolonged posteriorly like a tail.

Dujardin distinguishes this genus from *Euglena*, E., by the constancy of the form of the body, which varies every moment in the latter genus.

1. *P. pleuronectes* (Pl. 24. fig. 62). Body oval, almost circular, green, with slightly marked longitudinal furrows, and a tail-like prolongation one third or one fourth of its length. Aquatic; length 1-630″.

2. *P. longicaudus* (Pl. 24. figs. 3 & 63) = *Euglena longicauda*, E. (?)

3. *P. tripteris.* Aquatic.

4. *P. triquetrus* = *Euglena triquetra*, E.

Bibl. Duj. *Infus.* p. 334; Archer, *Qu. Mic. Jn.* 1871, 99.

PHÆOSPORE'Æ, Thur.—A division of the Melanophyceæ. Algæ.

They are the olive seaweeds. They have a foliaceous, shrubby or branched filamentous thallus, and are reproduced by zoospores having two cilia, one directed forwards and the other backwards. These are formed in clavate cells or multicellular filaments, collected in more or less definite groups on the cortical layer of the thallus of the larger kinds, and in lateral tufts or terminal on the branched filamentous kinds.

Bibl. Rabenh. *Fl. Eur. Alg.* iii. p. 393; Henfrey, *Elem. Course* (Masters), p. 436.

PHALANSTE'RIUM, Cienkow = Monas. The encysting process of *M. consociata*, Fres., is very interesting.

Bibl. Cienkow, *in Schultze's Archiv*, B. vi. p. 428, t. xxiii., xxiv., f. 29–33.

PHALLOIDE'I.—A family of Gasteromycetous Fungi, characterized by the protrusion of a large clavate, columnar, stellate body, or globular, hollow, latticed framework, from the summit of the burst peridium. The basidiospores must be observed early here, as they fall off and form a deliquescent mass upon the hymenium when the sporange is mature. The fleshy structure protruded from the dehiscent capsule is composed of spherical cells very loosely connected; the peridium, which is very tough, is composed of closely packed, very slender, filamentous cells.

Bibl, Berkeley, *Ann. Nat. Hist.* iv. 155; *Brit. Flor.* ii. pt. 2. p. 226; Rossmann, *Bot. Zeit.* xi. p. 185 (1853).

PHALLU'SIA.—A genus of Ascidia. *P. mamillaris* was shown by Kölliker and Löwig to possess cellulose in its mantle, which behaves under reagents like that of the higher Algæ. Schacht states that the substance, which is insoluble in caustic potash and soluble in sulphuric acid, and which is turned a beautiful blue by iodine and sulphuric acid, and which therefore consists of cellulose, constitutes the interstitial substance of the cells, being homogeneous in *Phallusia* and fibrous in *Cynthia*, another Ascidian. He considers that the membrane of the cells is not cellulose, but that it is confined to a homogeneous substance in which many of them are comprehended. See pp. 132 & 144.

Bibl. Huxley, *Elem. Comp. Anat.*; *Trans. Roy. Soc.* 1851; *Brit. Assoc. Report*, 1852; *English Cyclop.* Art. *Mollusca*; Hancock, *Proc. Linn. Soc.* 1867; Schmidt, *Zur Vergleich. Anat. d. wirb. Thiere*, 1845, p. 61; Kölliker & Löwig, *Ann. d. Sci. Nat.* 1846, p. 193; Schacht, *Müller's Archiv*, 1851; *Qu. Mic. Jn.* 1853, p. 34.

PHARCID'IA, Körb.—A genus of Micro-lichens found on the apothecia of *Lecanoræ*.

Char. Spores 8, 2–4-locular, colourless, linear, or rod-shaped.

Bibl. Lindsay, *Qu. Mic. Jn.* 1869, p. 343.

PHASCA'CEÆ.—A family of inoperculate Acrocarpous (terminal-fruited) Mosses, of minute dimensions, gregarious or cæspitose, with a simple or branched stem. Leaves oblong, oval, lanceolate or spathulate, concave, with a thick cylindrical nerve; the cells of the leaves parenchymatous, looser at the base, by degrees denser towards the summit, mostly papillose. Capsules mostly obliquely apiculate, with spores larger than in most Mosses, but not so large as in Archidium. Columella soon vanishing in the smaller species.

British Genera.

1. *Acaulon.* Plants very dwarf, gregarious. Capsule contained in the closed perichæte. Calyptra mitre-shaped, dimidiate. Inflorescence monœcious (antheridia on a distinct branch at the base of the stem), or diœcious (antheridia terminal on a distinct plant), bud-like.

2. *Phascum.* Plants cæspitose. Perichæte open. Capsule on a longish stalk, and mostly obliquely apiculate. Calyptra dimidiate. Inflorescence monœcious (antheridia terminal in a bud on a distinct lateral branch, or naked and axillary on the fruit-bearing branch), or diœcious.

PHAS'CUM, L.—A genus of Phascaceæ (Acrocarpous Mosses), which is now subdivided variously by different authors. Wilson separates the earlier *Ph. alternifolium* only, under the name of *Archidium*; foreign authors further distinguish between PHASCUM, ACAULON, EPHEMERUM, and ASTOMUM. Species retained: *Ph. crispum*, Hedw.; *cuspidatum*, Schreb.; *curvicollum*, Hedw.; *rectum*, Smith; *bryoides*, Dicks. *Ph. cuspidatum* is very common on banks, and especially on a gravelly soil.

BIBL. Wilson, *Bryol. Brit.* 32; Hooker, *Brit. Fl.* ii. pt. 1. p. 6.

PHIALI'NA, Bory, Ehr.—A genus of Infusoria, of the family Trachelina.

Char. Body finely ciliated, having a kind of neck crowned with large cilia; mouth lateral, below the appendix to the neck.

1. *P. viridis* (Pl. 24. fig. 61). Body oval, flask-shaped, green, suddenly narrowed in front and gradually behind; neck short. Aquatic; length 1-290″.

2. *P. vermicularis.* White; aquatic.

BIBL. Ehr. *Infus.* p. 333; Clap. et Lach. *Etudes*, p. 304.

PHILODI'NA, Ehr.—A genus of Rotatoria, of the family Philodinæa.

Char. Eyes two, cervical; tail-like foot with horn-like lateral processes.

Ehrenberg describes seven species; they are all aquatic, and in general structure and appearance closely resemble *Rotifer.*

P. erythrophthalma (Pl. 35. fig. 17). Colourless, smooth, eyes round, processes of foot short. Aquatic; length 1-120 to 1-50″.

P. roseola is reddish, and the eyes oval; *P. collaris* has a projecting cervical ring; *P. citrina* has the middle of the body yellowish; *P. macrostyla* has oblong eyes, and the foot-processes very long; in *P. megalotrocha* the eyes are oval, and the rotatory organs very large; and in *P. aculeata* the body is covered with soft setaceous processes.

BIBL. Ehr. *Infus.* p. 498; Pritchard, *Infus.* p. 705.

PHILODINÆ'A, Ehr.—A family of Rotatoria.

Char. No sheath or carapace; rotatory organs two, simple, resembling two wheels when the cilia are in motion.

The body is usually cylindrical, or somewhat spindle-shaped, contractile even so as to form a ball. In certain states of extension it sometimes appears pointed in front, from the presence of a proboscis; in others the two ciliated rotatory organs are protruded.

The animals are capable of swimming by means of the cilia, or of creeping like a leech, the ends of the body being alternately fixed. The tail-like foot is often furnished with horn-like lateral processes and terminal toes.

Ehrenberg distinguishes seven genera.

A. Eyes absent.	
α. Proboscis and horn-like lateral process on the foot present ...	1. *Callidina.*
β. Proboscis and horn-like processes absent ...	
a. Rotatory organ stalked	2. *Hydrias.*
b. Rotatory organ not stalked ...	3. *Typhlina.*
B. Eyes present.	
Eyes two, frontal.	
Foot with horn-like processes.	
Toes two ...	4. *Rotifer*
Toes three...	5. *Actinurus.*
Foot without horn-like processes, but with two toes ...	6. *Monolabis.*
Eyes two, cervical ...	7. *Philodina.*

BIBL. Ehrenberg, *Infus.* p. 481.

PHILOME'DES, Liljeborg.—A Cypridinad, with suboval valves, notched in front, spined behind, punctate. Upper antennæ 6-jointed, longer in the male: natatory branch of lower antennæ 9-jointed, secondary branch setose in the female, cheliform in the male. Eyes small and pale in female, large and red in male. 1 British species, rare.

BIBL. Brady, *Tr. Linn. Soc.* xxvi. 377; *Proc. Zool. Soc.* 1871, 291.

PHILOP'TERUS, Nitzsch.—A genus of Anoplurous Insects, of the family Philopteridæ.

Char. Antennæ filiform, five-jointed; maxillary palpi none; mouth with strong toothed mandibles; tarsi with two claws.

The species are very numerous, and have been arranged in six subgenera: *Docophorus*, *Nirmus*, *Goniocotes*, *Goniodes*, *Lipeurus*, and *Ornithobius.* In some of them there are two movable organs (trabeculæ) situated in front of the antennæ.

They are external parasites of birds.

P. (*Docophorus*) *communis* (Pl. 28. fig. 5). Chestnut-coloured, shining, with white hairs; head triangular, elongate, anterior portion much produced; trabeculæ very large, curved; posterior femora much incrassated and toothed below. Length 1-16″.

Parasitic upon the Passerina or Insessores.

BIBL. Denny, *Anoplur. Monogr.* p. 62.

PHLE'BIA, Fr.—A genus of Hymenomycetous Fungi, intermediate between Hydnei and Auricularini. The hymenium is soft and pinched up into crest-like wrinkles or veins, which do not form distinct pores. Four species are found in this

country, of which two at least are very pretty when in perfection.

Bibl. Fr *Syst. Myc.* i. p. 426; Grev. t. 280; Hass. ii. t. 44; Berk. *Outl.* p. 263; Cooke, *Handb.* p. 305.

PHLYCTÆ'NA, Desmaz.—A genus of Sphæronemei (Coniomycetous Fungi), nearly related to *Septoria*, differing in the absence of a proper perithecium. *P. vagabunda* has been found in Britain.

Bibl. Berk. and Broome, *Ann. Nat. Hist.* 2nd ser. xiii. p. 460; Desmazières, *Ann. des Sc. Nat.* 3 sér. viii. p. 16.

PHLYCTÆ'NIA, Kg.—A genus of Diatomaceæ.

Char. Frustules those of *Navicula*, enclosed in gelatinous globular cells (masses?). Marine.

1. *P. minuta.* Cells 1-720 to 1-240" in diameter; length of frustules 1-1200 to 1-600".

2. *P. maritima* (*Frustulia mar.*, E.).

Bibl. Kützing, *Sp. Alg.* p. 96; Ehrenberg, *Infus.* p. 232.

PHLYCTID'IUM, Not. See Discosia.

PHOLIO'TA.—A subgenus of *Agaricus* belonging to the ferruginous spored series, remarkable for the highly developed ring. *A. mutabilis*, with one or two others, is esculent. Many of the species are very beautiful and attractive.

Bibl. Fr. *Ep.* p. 160; Berk. *Outl.* p. 149; Cooke, *Handb.* p. 104.

PHO'MA, Fr.—A genus of Sphæronemei (Coniomycetous Fungi). There are numerous British species, forming small black or brown pustules upon dead leaves, twigs, &c. Tulasne regards this genus as formed by pycnidiiferous states of Sphæria.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 285; *Ann. Nat. Hist.* vi. p. 263; 2 ser. v. p. 368, xiii. p. 459; Fries, *Summa Veg.* p. 421; Tulasne, *Ann. des Sc. Nat.* 4 sér. v. p. 115.

PHORMID'IUM, Kütz. See Oscillatoria.

PHOR'MIUM, Forst.—*P. tenax* is the name of the plant yielding New-Zealand Flax. It is a Monocotyledonous Flowering Plant belonging to the order Liliaceæ.

PHOTOGENIC STRUCTURES.—The luminous appearance or phosphorescence of the sea is produced by many kinds of Invertebrata; and several Arthropoda are light-emitting on land. Decomposing animal and vegetable structures occasionally are phosphorescent; but their method of production of light differs greatly from that of the living animal; it is the result of putrefaction and decomposition. The structures implicated in the so-called phosphorescence of animals should be termed photogenic; for although the luminous glow resembles that of phosphorus, it is not proved that this element has much to do with it. There is a vast amount of indefinite knowledge on this subject; and most of the histology bearing upon it has been the result of the work of the last few years. It appears that certain animals are luminous during (1) muscular contraction, (2) normal excitement of protoplasm which is not differentiated, (3) artificial excitement of the nerve, (4) the normal action of special photogenic cells, (5) the usual action of special photogenic tissues containing or covered by cells, (6) nervous action. There are many small marine Annelida which are luminous; and the phenomenon consists of a quick series of scintillations, which pass along several segments of the body, lasting but an instant. They can be produced by artificial excitement, such as scratching, puncturing, and squeezing. Quatrefages considers that the light is given out by the muscular fibre during contraction. *Noctiluca miliaris*: in this highly phosphorescent animal, the outermost layer of the structureless protoplasm of the body, which is included in a celless pellicle, is the seat of the luminous phenomena. Allman describes the light, under the microscope, as being a succession of rapidly evanescent scintillations. An artificial stimulus will produce the phenomena when the Noctilucæ are otherwise non-luminous. The luminous Medusæ and *Beroæ* have an amount of fatty matter in the cells of some parts of the exterior epithelium; and this is luminous when in its normal position, and also when it has escaped into the sea by accident or by a probably natural method.

The *Pennatulidæ* are luminous under certain circumstances, and some species are remarkably photogenic. Spallanzani, when compressing the base of a *Pennatula*, obtained a luminous jet at the extreme pore of the stem; and it is well known that crushing with the hand destroys the stem, which contains certain luminous structures that escape. This matter is fatty, and resembles that which is contained in the cells of the epithelium of phosphorescent Medusæ and Beroides. Panceri states that, in all the phosphorescent Pennatulidæ, the light emanates exclusively from the polyps and zooids—that their phosphorescent organs consist of eight cords, which adhere to the

external surface of the stomach of the polyps and zooids and are continued into the buccal papillæ; and he shows that the cords are principally composed of a substance contained in vesicles or cells, which has all the characters of fatty matter, and does not decompose immediately after the putrefaction of the polyps. There are also multipolar cells and albumenoid granulations.

In *Pennatula phosphoria* he found a mineral substance white, granular, and indefinite in its composition, but which is neither a carbonate nor a calcareous phosphate. It renders the cords very white and visible through the transparent integuments. This photogenic matter and the substance of the cords pass readily into the tentacles of the polyp on pressure. The photogenic matter may become luminous by direct irritation, and also by the application of a distant stimulus; and it is evident that currents of luminosity pass up and down the *Pennatula*.

Pholas dactylus, one of the Conchifera, is often highly photogenic. The whole of its surface glows, and even also the water surrounding it. Careful washing gets rid of much secretion which is luminous, and discovers the true photogenic organs, which are:—1, an arch of tissue corresponding to the superior edge of the mantle, which reaches to the middle near the valves; 2, two small triangular spots placed at the entrance of the anterior siphon; 3, two long parallel cords in the same siphon. These parts stand out in relief on the mantle of which they form portions, their white colour distinguishing them. The triangular organs and cords present parallel furrows, which crimp and separate them into several lobes. But these structures are only elevations of the subcuticular tissue, covered, nevertheless, with a special epithelium, which produces phosphorescent matters. The whole surface of the *Pholas* is covered with ciliated epithelium, which dips down into all the parts of the animal; but the nuclei of the cells of the photogenic organs present a granular aspect, and the granulations project. The cell-contents are granular, and their contour is very indefinite. The cells are very fragile, and allow their contents to escape very readily. When a glass slide is pressed against these cells, a white substance escapes and adheres to it, becoming luminous. It consists of the granular nuclei and of small oil-drops. In fact the contents of the cells and nuclei are phosphorescent, and they are readily wafted over the animal by the cilia of its epithelium.

This photogenic matter is soluble in alcohol and ether. In *Pyrosoma*, one of the Tunicata, which contributes to the luminosity of the sea, the photogenic organs are in couples in the inner surface of the tube at equal distances from each other; they are so numerous that the thousands of brilliant points combine to produce a very brilliant glow. Panceri noticed that the light came from two points over the position of the ganglia of the Ascidia. The particular spots in the Ascidia are the small bodies which Huxley described as "cell-masses," without deciding upon their office. They are oval, and are placed between the two tunics of the teguments, being exclusively attached to the external. These cells have no nucleus, and contain a substance soluble in ether, and also an albuminous substance. No nerve-filaments seem to be given off from the ganglion close by. The photogenic substance is in all probability fatty matter; and Panceri asserts that it presents the same phenomena as the matter he found in the luminous organs of the *Pennatulæ*, in the cells of the exterior epithelium of the phosphorescent *Medusæ*, as also in the special organs of the *Pholades*, in the *Chætopteri* and *Beroæ*; and it reacts with stimulants just as that contained in the *Noctilucæ* and *Thalassicollæ*. In *Phyllirrhoe bucephala*, however, the photogenic matter is clearly connected with the nervous system; it is found in the peripheral nervous cells of the ordinary form, and in those of the central ganglia, as well as in the special peripheral cells, which contain a refractive yellow matter soluble to a great extent in alcohol and ether.

These may be taken as examples of the photogenic marine animals and structures; and in considering them it must be remembered that the development of the fatty matter is due to their processes of assimilation, nutrition, and respiration. The oxygenation of the fatty matter proceeds normally during life, and is in some instances perfectly independent of nervous influence. Where no special photogenic structures exist, the luminosity can only be produced by molecular, physical, and with or without chemical changes.

The glowworm, genus *Lampyris*, may be taken as the type of terrestrial luminous insects. The luminosity is not restricted to the female; and even the egg and the young

larva are luminous in some species. The glowworm's light is most brilliant in fine open warm weather in June or July, and usually is most brilliant before midnight; but some species keep up their light until dawn. The organ of light of the larva is on the lower and lateral surface of the last segment but one of the abdomen, where there are two bright points which come close to the under surface of the next segment, so that when the insect extends its abdomen and separates the segments they become visible; but when it contracts, then they are hidden. The luminous points are connected with little sac-like bodies under the skin. Each sac consists of a membrane enclosing fluid contents and a large quantity of granules, and it is covered here and there with nerves and air-vessels. If the sacs be dissected out, they still remain luminous for a while, and even when torn to pieces the shreds emit light. Air is requisite, and moisture also.

The mature female of *Lampyris splendidula* has luminous organs on the three segments of the abdomen preceding the last. They are on the under part and side of the segments. The organ is a thin leaf-like mass of a white colour, and is beneath the skin of the segment, and is greatly supplied with tracheæ and nerves. Each mass or lamina consists of collections of cells, each of which is in close contact with a trachea, and is either organically connected with a nerve or the nerve passes in close contiguity. The laminæ are close to the abdominal ganglia. The cells are both large and small, and contain granules and nuclei; and the former disappear to a great extent, and the latter become more visible under liquor potassæ. A nervous plexus exists on the membrane which encloses the cells. In *Lampyris* the generative organs are close to the luminous organs; and probably their increased vascularity produces such an amount of nervous action and respiratory vigour that the phenomena of animal heat are replaced by an oxygenation of the albumenoid and fatty matter of the cells, which determines the production of luminous rays.

Bibl. Owsienikow, *Acad. St. Pétersb.* t. xi.; Quatrefages, *Ann. Sci. Nat.* sér. 2, *Zool.* t. xix., & sér. 3, *Zool.* t. xiv.; tr. *Pop. Sci. Review*, vol. v.; A. Agassiz, *Sea-side Studies, Boston*, p. 88: Panceri, *Atti d. R. Accad. d. Sci. F. e. M. di Napoli*, 1872; Allman, *on Noctilucæ, Qu. Mic. Jn.* 1872, p. 326; and notices in the same Journal for 1872 of Panceri's works; Fripp, *Pop. Sci. Review*, vol. v. p. 314.

PHOTOG'RAPHY. — Microscopic objects may be photographed by the ordinary methods, especially by the collodion process, by arranging the microscope so as to form the optical part of a camera obscura. The old solar microscopes are examples of the principle of such an arrangement. Microscopic cameras have been constructed in which the lens is replaced by a fitting carrying achromatic objectives, with the rod bearing the stage and illuminating apparatus, as in the ordinary stands of compound microscopes. Mr. Delves perfected an admirable camera very early in the history of micro-photography. A simpler plan for those who possess a compound instrument and a camera, is to remove the lens of the latter and introduce into its place the eye-end (with the eyepiece removed) of the compound body, placed in a horizontal position; filling up the crevice all round with a piece of black velvet or cloth. Another method (Wenham's), which enables us to dispense with the camera, is to operate in a room darkened by a shutter having an orifice through which the sunlight may be reflected by a mirror placed outside, and received either directly or condensed by a bull's-eye, on the object lying on the stage of the compound microscope placed horizontally, with the eyepiece removed; a screen placed at a suitable distance from the eye-end of the tube receives the image. In operating with this screen, the object should be focused on a sheet of card, and then, the light being shut off by covering the eye-end of the tube, a prepared paper or collodion plate be substituted exactly in the same place. Means must be used, by a black cloth or similar contrivance, to shut off all side light between the orifice of the shutter and the objective. In this last process, it is possible to obtain pictures with different parts of the object not lying in the same plane, by separate focusing, applying pieces of card suitably cut to shut off the image at different parts as required. With very minute objects and high powers, the achromatic condenser is used, as well as the bull's-eye.

It is well known that the correction of the objectives for perfect vision is not the best for photographic purposes. With high powers, as the 1-4″ objective and upwards, the difference may be neglected, but with lower powers, an adjustment is required.

Mr. Shadbolt finds it sufficient to withdraw the objective a little way, by the fine adjustment, from the object, and gives the following data for Smith and Beck's objectives: for the 4-10″, withdraw the objective 1-1000″; for the 2-3″, withdraw it 1-200″; for the $1\frac{1}{2}$″, withdraw it 1-150″. Mr. Wenham prefers to place a doubly convex lens in the place of the back stop of the objective, and advises for the 4-10″ and 2-3″ objectives a lens of 5″ focus; for the $1\frac{1}{2}$″ objective, a lens of 8″ focus.

Microscopic photographs are best obtained with solar light; but artificial light has been used—camphene or gas for low powers, the oxyhydrogen light for high powers. Dr. Maddox has used the magnesium light. A great point is to secure clean preparations, with the object sufficiently flat to allow of being clearly focused all over; this sets a limit to the utility of the process; further, certain objects in which red and yellow, or yellowish-brown colours exist, do not transmit the light, or only imperfectly. It will probably be advantageous to bleach many objects, as, for instance, insects and their parts, by long maceration in turpentine, sections of dark-coloured wood by nitric acid, &c., when they are intended to be photographed.

The purely photographic manipulation cannot be given here, but requires the ordinary skill in photography. Lengthened particulars respecting the application of photography to the microscope are contained in the papers referred to below.

Bibl. Delves, *Trans. Mic. Soc.* i. 1853, p. 57; Highley, *Qu. Mic. Jn.* i. pp. 178, 305, and ii. p. 158; W. T. Kingsley, *Jn. Soc. Arts,* 1853; *Photo. Journal,* i. p. 93; Shadbolt, *Qu. Mic. Jn.* ii. p. 165; Wenham, *Mic. Trans.* 1855, 2 ser. iii. p. 1; Rood, *Qu. Mic. Jn.* 1862, p. 261; Hessling and Kollmann, *Atlas d. thier. Geweb.* 1862; Maddox, *Trans. Mic. Soc.* 1863, p. 9; *ibid.* 1865, p. 34; *Jn. Lond. Photo. Soc.* 1864; *Mo. Mic. Jn.* 1869, p. 27; Woodward, *ibid.* p. 29, vol. iii. p. 290; *Qu. Mic. Jn.* 1870, p. 380; *Brit. Jn. Photo.* 1866; Jules Girard, *Phot. Soc. France*; Moitessier, *Photog. Appliquée,* 1866; Reichardt and Sturenburg, 1868, *Mon. mik. Phot.*; Frey, *Das Mik.*; Beale, *How to Work,* and the notices therein of the writings of Maddox, Woodward, Curtis, Gerlach, Rood, Abercrombie and Wilson, Neyt, Rev. M. Reade, Moitessier, Castracana, Shadbolt, Legg, Parry, Hislop, Wenham, and Heisch.

PHRAGMIC'OMA, Dumort.—A genus of Jungermannieæ (Hepaticæ), containing one British species, *P. Mackaii* (*Jung. Mackaii*, Hook.), occurring rarely on trees and rocks, especially on limestone.

Bibl. Hook. *Brit. Jung.* p. 53; Ekart, *Syn. Jung.* p. 59, pl. 9. fig. 72; Endlicher, *Gen. Plant.* Suppl. i. 472–9.

PHRAGMID'IUM, Lk. (*Aregma*, Fr.).—A genus of Uredinei (Coniomycetous Fungi), forming rusts very common on Rosaceous plants. They appear upon living leaves, breaking through from beneath the epidermis, and are chiefly distinguished from Puccinia by the number of septa which are contained in the spores or pseudospores. *P. bulbosum* is common, forming yellow and brown pulverulent spots on bramble-leaves (see Aregma).

Fig. 565.

Phragmidium bulbosum.
Isolated basidium with four septate spores. Mag. 100 diams.

Bibl. Berk. (*Aregma*), *Brit. Flor.* ii. pt. 2. p. 358; Grev. *Sc. Crypt. Flor.* pl. 15; Tulasne, *Ann. des Sc. Nat.* 4 sér. ii. p. 180, pl. 9; De Bary, *Brandpilze,* Berlin, 1853, p. 49, pl. 4; Fries, *Summa Veg.* p. 507; Currey, *Quart. Journ. Micr. Sc.* v. p. 117.

PHRAGMOTRICHA'CEI.—A division of Coniomycetes distinguished from Melanconei by their moniliform chains of spores. See Coniomycetes.

PHRAGMOT'RICHUM, Kze.—A genus of Phragmotrichacei (Coniomycetous Fungi). The plants form little tubercles burst-

Fig. 566.

Fig. 567.

Fig. 568.

Phragmotrichum Chailletii.

Fig. 566. Scale of a spruce-fir cone, with pustules. Half nat. size.
Fig. 567. A pustule, magnified 10 diameters.
Fig. 568. Vertical section across a pustule, showing the chains of spores. Magnified 100 diams.

ing out from beneath the epidermis, and containing filaments arising from a softish fibrous stroma. The filaments (basidia) are interrupted at intervals with cellular spores (fig. 568), which ultimately separate. *P. Chailletii* grows upon the scales of the cones of *Abies excelsa.* Other species grow on the poplar and maple.

BIBL. Fries, *Syst. Myc.* iii. p. 492; *Summa Veg.* p. 474; Berk. *Crypt. Bot.* p. 327.

PHTHIR'IUS, Leach.—A genus of Insects, of the order Anoplura, and family Pediculidæ.

Char. Legs of two kinds, anterior pair formed for walking, posterior two pairs formed for climbing; thorax large, not distinctly separated from the abdomen.

One species, *P. inguinalis* (*Pediculus pubis*). Parasitic upon man. Length 1-10 to 1-20″.

The ova are firmly fastened to the hairs by a glutinous secretion; they are urn-shaped, and furnished with a lid.

BIBL. Denny, *Anoplur. Monogr.* p. 8; Leach, *Zool. Misc.* iii. p. 65.

PHYCOMY'CES, Kze.—A genus of Mucorini (Physomycetous Fungi), of which one species, *P. nitens,* has been found in Britain growing on the walls of oil-cellars and on grease. It is an olive-coloured mildew, distinguished from *Mucor* chiefly by the absence of a columella, the pyriform peridiole, and oblong spores; but the entire plants are much larger and of more solid texture. The fertile filaments of *P. splendens,* the only other known species, are as thick as a horse-hair, and 3 to 4″ high.

It is the finest of all the Mucorini, and was at first considered an Alga, which it strongly resembles on a superficial examination, when dry, from its green shining threads.

Van Tieghem attributes to this a fructification like that of *Syzygites,* with which genus it must ultimately be combined.

BIBL. Fries, *Syst. Myc.* iii. p. 309; *Summa Veg.* 488; Berk. *Ann. Nat. Hist.* vi. p. 433; Van Tieghem, *Ann. d. Sc. Nat.* 1873, xvii. p. 292.

PHYLLODE'I.—A series of Lichenacei.

Char. Thallus foliaceous, depressed, lobed.

BIBL. Leighton, *Brit. Lich. Flora,* p. 2.

PHYLLOGONIA'CEÆ.—A family of Pleurocarpous Mosses, distinguished by the peculiar character of the leaves and their arrangement. The leaves are either inserted horizontally or imbricated vertically, clasping, and are composed of very narrow linear parenchymatous cells, appearing almost confluent into a homogeneous membrane, auricled at the base, with minute, parenchymatous, thickened alar cells arranged orbicularly at the auricles, very smooth; the leaves stand in two opposite rows.

This family contains only the single small exotic genus *Phyllogonium.*

PHYLLOPH'ORA, Grev.—A genus of Cryptonemiaceæ (Florideous Algæ), consisting of several species, with a red, rigidly membranous, stalked, leaf-like, often dichotomous thallus, the lobes of which are often proliferous; from a few inches to a foot long, growing near low-water mark, or in the sea.

The fructification consists of:—1. *favellidia,* scattered over the thallus, containing minute spores; 2. *antheridia,* wart-like bodies composed of radiating moniliform filaments found on distinct plants from the spores; and 3. *tetraspores,* collected into sori either towards the apex of the thallus or on proper lobes.

BIBL. Harvey, *Brit. Mar. Alg.* p. 142, pl. 18 A; *Phyc. Brit.* pl. 191, &c.; Greville, *Alg. Brit.* pl. 15; Derbès and Solier, *Ann. des Sc. Nat.* 3 sér. xiv. p. 277, pl. 37; Thuret, *ibid.* 4 sér. iii. p. 18.

PHYLLOP'ODA. See ENTOMOSTRACA.

PHYMATOP'SIS, Tul. — A genus of Micro-lichens parasitic on the apothecia and thallus of Usneæ.

BIBL. Lindsay, *New-Zealand Lich. and Fungi,* p. 442; *Qu. Mic. Jn.* 1869, p. 350.

PHYSAC'TIS, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), improperly separated from *Rivularia,* consisting of aquatic and marine plants, growing on stones &c., at first globose, and afterwards vesicular and lobed by peripheral growth accompanied by gradual decay of the originally solid centre. Under this head are included:—

1. *P.* (*Rivularia*) *nitida.* Deep olive-green, tufted and lobed, gregarious; fronds from 1-12 to 1″ in diameter. (*R. bullata,* Berk.) Marine.

2. *P.* (*Riv.*) *plicata.* Diam. 1-12 to 1-2″ in diameter; deep green. Marine.

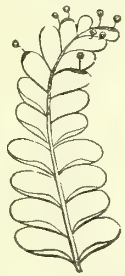
3. *P.* (*Riv.*) *pisum.* Globose, dirty green, 1-12 to 1-2″ in diameter. Aquatic.

BIBL. Kütz. *Sp. Alg.* p. 332; *Tab. Phyc.* Bd. i. pl. 58, &c.; Hassall, *Br. Fr. Alg.* p. 262; Harvey, *Br. Mar. Alg.* p. 222; Berk. *Gleanings,* pl. 2. fig. 1; Rabenht. *Fl. Eur. Alg.* ii. p. 206.

PHYSA'RUM, Pers.—A genus of Myxo-

gastres (Gasteromycetous Fungi), containing numerous species growing on rotten wood, bark, leaves, &c. They are nearly related to *Didymium* and *Diderma*, but have a simple membranous peridium: the filaments are adnate to the peridium; but in some spores they are very few, approaching to the condition of *Licea*. Some are sessile, others stipitate (fig. 569); the clus-

Fig. 571. Fig. 569. Fig. 570.



Physarum bryophilum.

Fig. 569. Plants growing on a Plagiochila. Magn. 2 diams.
Fig. 570. A peridium burst. Magnified 25 diameters.
Fig. 571. Filaments and spores from the same. Magnified 100 diameters.

tered forms (*P. hyalinum* and *utriculatum*) are removed to Berkeley's genus Badhamia. *P. album* is common.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 314; *Mag. Zool. and Bot.* i. p. 49; *Ann. Nat. Hist.* vi. p. 431, 2nd ser. xiii. p. 159; Fries, *System. Myc.* iii. p. 127; *Summa Veg.* p. 153; Greville, *Sc. Crypt. Fl.* pl. 40. 310.

PHYS'CIA. See Borrera.

PHYSCOMIT'RIUM, Bridel.—A genus of Funariaceæ (Acrocarpous Mosses), including many *Gymnostoma* of other authors. *Physcomitrium pyriforme*, Brid. = *Gymnostomum pyriforme*, Hedw. *Ph. sphæricum* is remarkable as having been found only in one year in one locality in Britain.

This species exhibits a pretty structure in a vertical section of the immature capsule, the mass of sporiferous tissue being suspended freely in the middle by cellular threads.

PHYSIO'TIUM, Nees.—A genus of Jungermannieæ (Hepaticæ), containing one species, *P. cochleariforme*, a large plant, growing in purple tufts 4 to 6″ long, on moors and among rocks in Ireland and the Scotch highlands.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 119; *Br. Jung.* p. 68; *Engl. Bot.* pl. 2500; Ekart, *Synops. Jung.* pl. 5. fig. 40; Endlicher, *Gen. Plant.* Suppl. 1. nos. 472–18.

PHYSODIC'TYON, Ktz.—A genus of Confervoid Algæ.

Char. The globular vesicular thallus formed by angular parenchymatous cells containing masses of chlorophyll. Propagation unknown.

Bibl. Rabenht. *Fl. Eur. Alg.* iii. p. 312.

PHYSOMYCE'TES.—An order of Fungi composed of microscopic plants of very simple organization, the mycelium being a byssoid or flocculent mass, bearing simple vesicular sporanges (*peridiola*), filled with minute spores. The nature of the membranous wall of the peridioles is not yet well ascertained in all the genera, some authors describing it as merely a veil, others as a perfect sac formed by the expansion of the terminal cell of the filament, which is certainly true in *Mucor*. According to our own observations, the spores are formed by free-cell formation in the peridiole, which ultimately bursts to discharge the spores.

The distinction between the two families seems to depend chiefly on the conditions of the peridioles; but it seems doubtful whether the Antennariei can stand; Antennaria seems to be merely a form of Capnodium; and Pisomyxa and Pleuropyxis are obscure objects of which little is known.

In the Antennariei the peridioles are sessile on radiating flocci, which sometimes send processes which grow up and surround them, or they are attached to the sides of erect filaments; these filaments form whitish or greyish patches, on the leaves of trees and herbs, bearing a close external resemblance to *Erysiphe*.

The Mucorini are moulds growing on decaying organic matter, the mycelium constituting flocks floating in liquids or overgrowing damp substances, while the delicate spore-sacs or peridioles are borne at the apices of erect stalk-like and often extremely branched filaments. The genus *Syzygites* exhibits a remarkable peculiarity, according to Ehrenberg; for he states that each spore-sac is formed by means of the conjugation of two branches of the ramified fructification (see Syzygites).

The later researches on the plants of this group seem to indicate that, as in most of the Fungal Orders, much remains to be cleared up concerning the relations of the forms. See on this subject the article Eurotium, which genus, according to De

Bary's researches, is associated as merely a second form of fructification, with ASPERGILLUS, upon the same mycelium recent observations lead us to doubt the accuracy of these views; but this genus should, we think, stand among the PERISPORACEI.

Synopsis of the Families.

1. ANTENNARIEI. Mycelium filamentous, radiating, or erect, bearing sessile, globular, membranous sacs (*peridiolodes*), filled with ovate spores, discharged by the rupture of the sac at its apex.

2. MUCORINI. Mycelium filamentous, vague, giving off erect simple or branched filaments terminating in vesicular cells (*peridioles*) filled with minute spores; often with a central column in the interior.

BIBL. See the genera.

PHYTEL'EPHAS, R. and P.—The generic name of the Palm yielding the VEGETABLE-IVORY nut.

PHYTOCRE'NE, Wallich.—An Artocarpaceous tree with wood of very remarkable structure. See WOOD.

PHYTOZO'A. — A group of Infusoria which contains flagellate Infusoria and many Algæ. In the present confusion of the classification of the simpler forms of life it is a useful, comprehensive, but artificial and temporary assemblage. It contains the *Monadina*, *Cryptomonadina*, *Hydromorina*, *Volvocina*, *Vibrionia*, and *Astasiæa*.

BIBL. Pritchard, *Infusoria*, p. 111.

PIGGO'TIA, Berk. and Broome. — A genus of Sphæronemei (Coniomycetous Fungi), or perhaps the conidiiferous form of *Dothidea*. *P. astroidea* occurs on the green leaves of the elm, forming irregular roundish, granulated or wrinkled jet-black patches (sometimes with a yellow border) on the upper surface of the leaf. Perithecia soon confluent, bursting by a lacerated fissure.

BIBL. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. vii. p. 95, pl. 5. fig. 1.

PIGMENT. See INTRODUCTION, p. xxx.

PIGMENT-CELLS of connective tissue occur only in a few isolated spots in Man and the higher Vertebrata, and are widely distributed in Amphibia and Pisces, appearing especially in the skin, serous membranes, and in the tunica adventitia of the vessels. In these places pigment is deposited in the form of granules, which differ both in shape and colour. The pigment-cells of connective tissue are usually characterized by their beautiful stellate form and numerous processes. In Man they occur normally in the eye, and the pigment is brown or black, the granules are subcylindrical, with rounded extremities, and consist of melanin. The pigment-granules in Amphibia are collected in round masses, and at other times are diffused in the stellate cells, their movement being evident but slow. Spontaneous change of form of pigment-cells occurs in the skin of these animals, and is connected with the phenomena of the change in colour which they present.

Pigment in disease, consult Rindfleisch, *Path. Hist.*; Green, *Path. and Morb. Anat.*

PIGMENTATION of Skin.—Whether in coloured moles, warts, or freckles, the pigment is deposited in the form of yellow, brown, or black granules, partly in the cells of the rete Malpighii and connective tissue, and partly outside them, freely distributed throughout the connective tissue of the papillary body (see SKIN). The discoloration seen in some persons who have taken salt of silver as a medicine depends upon the deposition of the element in the tissues.

Pigmentation of the lung usually depends upon the presence of carbon, stone, iron, &c. The material is inhaled, and granules of it penetrate the epithelial cells of the bronchi; much is expectorated, and the rest may descend into the vesicular structure of the lung and make its way into the surrounding connective tissue.

PILA'CRE, Fr.—A genus of Trichogastres (Gasteromycetous Fungi).

This genus must not be confounded with *Onygena*, to which it bears a certain resemblance. One or two of the species are remarkable for the strong permanent odour, resembling that of pigs.

BIBL. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. v. p. 365, pl. 11.

PILEOLA'RIA, Cast. See UROMYCES.

PILEORHI'ZA.—A conical hood on, or shield or guard to, the tip of the roots of plants, protecting the nascent tissue. See ROOT.

PILIDI'UM.—A larval form of a Nemertid of great length, which frequents the roots of Algæ. The larva is helmet-shaped, and a movable bristle-shaped appendage occupies the place of the plume.

BIBL. Leuckhart and Parenstecher, *Untersuch. ü. nied. Seethiere*, *Müller's Archiv*, 1853, p. 569.

PILIN'IA, Kütz.—A genus of Chætophoraceæ (Algæ). It is marine, and grows

in New Cuxhaven. The method of propagation is unknown.

Bibl. Kütz. *Phycol. gener.* p. 273; Rabenhorst, *Fl. Eur. Alg.* iii. 386.

PILOBO'LUS, Tode.—A genus of Mucorini (Physomycetous Fungi), consisting of little moulds growing upon dung; bearing some resemblance in their structure to *Botridium* among the Algæ. The plants have a stoloniferous creeping mycelium, from which arise fertile pedicels, each cut off from the mycelium by a septum; the upper part of the pedicel expands into the vesicle, which also becomes shut off by a septum; in the vesicle or peridiole, spores are next developed by free-cell formation, and at the same time the septum becomes pushed up into its interior (as in Mucor) to form a columella, which ultimately causes the vesicular peridiole to split off by a circumscissile dehiscence just above the septum; it is thrown off with elasticity, enclosing the spores. The development of *P. crystallinus* has been studied by Cohn and Bail. They find the germinating spore to produce a creeping unicellular mycelial portion, and next a fruit-pedicel, which soon has the peridiole separated by a septum: thus, in its simplest form, this plant consists of only three cells; subsequently it becomes complex by the root-cell or mycelium producing numerous stolons. *P. crystallinus* is yellowish at first, the peridiole finally black. *P. roridus*, Bolt., a doubtful species, is smaller and more slender than the last, having an elongated filiform stem.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 231; Fries, *Summa Veget.* p. 487; Cohn, *Nova Acta*, xxiii. p. 492; T. Bail, *Bot. Zeit.* xiii. p. 630; Currey, *Journ. Linn. Soc.* Botany, i. p. 162.

PILOPH'ORON, Tuck.—A genus of Cladodei (Lichenacei).

Char. Thallus verrucoso-granulate, bearing large fuscescent sessile cephalodia; podetia rigid, simple, minute; apothecia terminal, subglobose, black. One species. *P. fibula* is North American and Welsh.

Bibl. Tuck. *Syn. Lich. N. Amer.* p. 46; Leighton, *Brit. Lich. Flor.* 76.

PILOT'RICHUM, Pal. de Beauv.—A genus of Hypnoid Mosses, including some *Fontinales* of authors.

1. *Pilotrichum antipyreticum*, C. Müll. = *Fontinalis antipyretica*, L.

2. *P. squamosum*, C. Müll. = *F. squamosa*, L.

3. *P. ciliatum*, C. Müll. = *Anœctangium ciliatum*, Brid., *var. γ. striatum* = *A. ciliatum*, Wilson.

4. *P. heteromallum*, P. d. B. = *Daltonia heteromalla*, H. and T.

PILULA'RIA, L.—A genus of Marsileaceous Plants, containing the only British representative of the order—*P. globulifera* (fig. 574). This is an inconspicuous plant growing in mud at the edges of or in pools, having a filiform creeping stem, bearing erect filiform green leaves and delicate adventitious roots, and producing shortly-stalked globular spore-fruits, about the size of a pepper-corn. The anatomical structure of the stem and leaves is simple: they are clothed with an epidermis possessing stomata; and a cross-section both of the stem and the leaves exhibits a central vascular bundle (of spiral vessels) surrounded by a sheath of brownish cells, while in the delicate cellular tissue intervening between the central bundle and the epidermis stands a circle of air-passages separated from each other by simple radiating cellular septa.

Fig. 572.

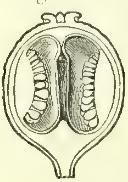
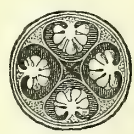


Fig. 573.



Pilularia globulifera.

Fig. 572. A vertical section of a spore-fruit. Magn. 5 diameters.

Fig. 573. Transverse section of a spore-fruit. Magn. 5 diameters.

The spore-fruits are hollow cases with an outer tough cellular coat, and an inner more delicate coat dipping in at four perpendicular lines, as far as the centre, so as to form dissepiments dividing the fruit into four chambers (figs. 572, 573); up the centre of the outer wall of each chamber runs a raised ridge (a kind of placenta), whence arise the sporanges or *thecæ* (fig. 573). These are pear-shaped sacs composed of a very delicate cellular membrane. Those in the upper part of each chamber contain a number of minute globular bodies, resembling pollen-grains, immersed in a gelatinous liquid. The sacs in the lower part of the chamber contain only one body or spore, but this of very peculiar form; it nearly fills the theca, is somewhat oval in form, and possesses several coats.

The development of the spores, as described by Valentin, is very curious: the small spores are developed in the usual way, by the formation of parent cells in the theca, which parent cells subsequently each produce four spores. In the thecæ which have the single large spore, a number of parent cells are originally produced; and these become divided into four chambers by septa; but then all but one of these decay. This produces four spores; but out of these four only one attains to perfect development, the rest being subsequently dissolved and absorbed to make room for the solitary large spore. The two kinds of spore in *Pilularia* correspond to the two forms in SELAGINELLA and ISOËTES, and to the pollen and ovules of the Flowering Plants. They are set free by the dehiscence of the spore-fruit, and lie at first imbedded in the jelly poured out by the thecæ.

In this state the small spores resemble pollen-grains, having an outer granular, and an inner delicately membranous coat,—the outer coat presenting ridges corresponding to the points of contact in the parent cell. When set free, the spores soon burst at these ridges, and the inner coat is slightly protruded; this next bursts and discharges a number of lenticular cellules, from each of which escapes a ciliated spiral spermatozoid.

The mature large spores (fig. 575) are of oval form, and have a thick outer gelatinous coat composed of prismatic cells standing perpendicularly on an inner glassy coat; the gelatinous coat is perforated at the summit by a funnel-shaped opening through which protrudes a pyramidal elevation of the

Fig. 574.

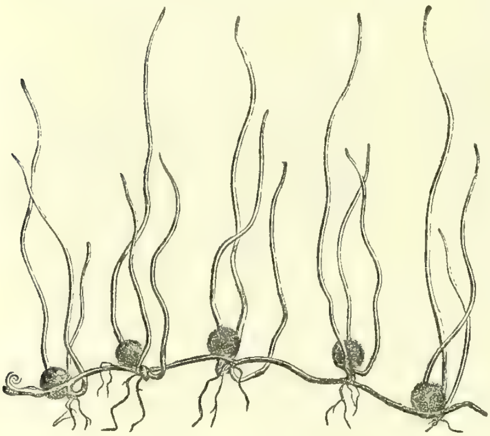


Fig. 575.

Fig. 576.

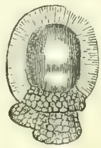


Fig. 577.

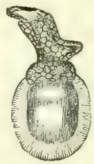


Fig. 578.

Pilularia globulifera.

Fig. 574. Natural size.
Fig. 575. An ovule spore. Magnified 25 diameters.
Figs. 576 & 577. The same in germination. Magnified 25 diameters.
Fig. 578. Germinating spore more advanced. Magnified 10 diameters.

second glassy coat; the last is lined by a delicate internal coat containing protoplasm, starch, oil-globules, &c. Soon after the expulsion of the spore, cell-formation takes place inside the pyramidal protrusion of the outer coat, from the cell-contents of the spore. The glassy coat next splits at this point into four teeth, and exposes the cellular structure (*prothallium*), which increases in size, and acquires a green colour. An archegonium is next formed on this, consisting of a cell (embryo-sac) lying in the substance at the apex, with a canal bordered by four papillose cells leading to it. A spermatozoid fertilizes the free embryo-cell contained in the archegonium; and this becomes developed into a new plant within the substance of the prothallium (fig. 577), sending out a leaf on one side and an adventitious root on the other, tangentally to

the surface of the spore. In this stage (fig. 578) the young plant, with the remains of the spore, somewhat resembles a germinating Monocotyledonous seed. Finally, as the young plant increases in size, the remnants of the spore-coat are thrown off.

Bibl. Valentine, *Linnean Trans.* xvii.; Schleiden, *Grundzüge*, 3rd edit. ii. p. 104 (*Principles*, p. 203); Hofmeister, *Vergleich. Untersuch.* Leipsic, 1851, p. 103, pls. 21, 22; Henfrey, *Ann. Nat. Hist.* 2 ser. ix. p. 447; *Trans. Brit. Assoc.* 1851, p. 116.

PINE-APPLE. See Bromeliaceæ.

PINNULARIA, Ehr.—A genus of Diatomaceæ, family Naviculaceæ.

Char. Frustules single, free, longer than broad; front view linear or oblong; valves navicular, elliptical, lanceolate, or oblong (side view), with a median line, and a nodule at the centre and at each end, surface exhibiting transverse or slightly radiating striæ or furrows (costæ).

This genus differs from *Navicula* in the striæ not being resolvable into dots. They are mostly distinct under ordinary illumination. In some of the species they are absent in the middle, leaving a transverse clear space or band, resembling in appearance the stauros of *Stauroneis*.

Many British species.

1. *P. nobilis* (Pl. 11. fig. 1, side view). Valves linear, dilated in the middle and at the rounded ends; striæ coarse. Aquatic and fossil; length 1-100 to 1-70″.

2. *P. viridis* (Pl. 11. fig. 2, side view). Valves elliptical, somewhat turgid, ends obtuse. Aquatic; length 1-500 to 1-220″. Common.

β. Striæ parallel, absent from a transverse band.

3. *P. oblonga* (Pl. 11. fig. 3, side view). Valves linear-oblong, ends rounded. Aquatic and fossil; length 1-120″. Common.

4. *P. radiosa* (Pl. 11. fig. 4, side view; fig. 5, front view). Valves lanceolate, ends somewhat obtuse. Aquatic; length 1-500″. Common.

Bibl. Smith, *Brit. Diatom.* i. p. 54, ii. p. 95; Ehr. *Abh.* 1840, p. 20; Donkin, *Mic. Jn.* 1861, p. 8; Pritchard, *Infus.* p. 899; Kütz. *Sp. Alg.* p. 81; Gregory, *Diatom. of Clyde*, p. 7; *Qu. Micro. Jn.* ii. pp. 28, 98; Grün, *in Wien. Verh.* 1860, p. 524; Rabenh. *Süssw. Diat.*; *Fl. Eur. Alg.* p. 209; Pfitzer, *quoted by* O'Meara, *Qu. Mic. Jn.* 1872, p. 386.

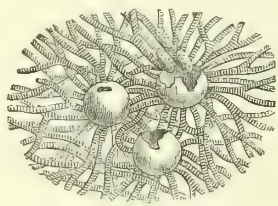
PI'NUS, L.—A genus of Coniferæ (Gymnospermous Flowering Plants), presenting many interesting points of structure. The most familiar example is the Scotch Fir (*P. sylvestris*); but a great number of other species are cultivated in this country. For the microscope they yield instructive objects:—in the wood (Pl. 39. fig. 1), composed of peculiarly pitted cells (see Coniferæ) and traversed by turpentine reservoirs; in the Bark, which has a kind of false cork; in the development of the Gymnospermous Ovules, and in the structure of the Pollen-grains.

The wood of species of the genus *Pinus* frequently occurs in a fossil condition (Pl. 19. figs. 29–33).

Bibl. See the articles above cited.

PISOMYX'A, Corda (*Bryocladium*, Ktz.).—A genus of Antennariei (Physomycetous Fungi), growing upon leaves. A species has occurred in Ceylon on the leaves of *Amomum*.

Fig. 579.



Pisomyxa racodioides.
Magnified 200 diameters.

Bibl. Fries, *Summa Veg.* p. 406; Corda, *Icones Fung.* i. pl. 6. fig. 292; Berk. and Broome, *in Linn. Soc. Jn.* xiv. p. 139, t. x. f. 54.

PISTIL.—The parts of a flower included in the terms ovary, style, and stigma. It is in theory composed of modified leaves or carpels.

PISTILLA'RIA, Fr.—A genus of Clavariei (Hymenomycetous Fungi), consisting of small club-shaped heads which are confluent with the stem. There are about six species indigenous to this country, of which that on fern-stems is the most common.

Bibl. Fr. *Ep.* p. 586; Berk. *Outl.* p. 286; Cooke, *Handb.* p. 342.

PISTILLID'IUM = Archegonium, the female reproductive organ of the higher Cryptogamia.

PITH. See Medulla.

PITTED STRUCTURES of Plants.—The secondary deposits of cellulose which form the layers of thickening of the walls of

vegetable cells are seldom uniform or homogeneous in character. In most, if not in all, cases some special microscopic structure may be distinguished, either by mere inspection or on the application of reagents. These layers, spoken of more particularly as to their nature under SECONDARY DEPOSITS, may be divided into two classes, comprehending pretty accurately all the varied conditions, namely:—the *Spiral deposits*, where the secondary layers assume the aspect of fibres applied upon the inside of the cell-wall; and *Pitted* or, as they are often termed, *Porous deposits*, where layers are applied over the whole internal surface of the cell, which layers present orifices of different characters, leaving the primary membrane bare, and forming in this way a *pit* as viewed from the inside of the cell. When the secondary layers are comparatively thin, their presence is often overlooked; and the pits have thus often been mistaken for orifices or *pores* (figs. 580, 581) in the primary

Fig. 580. Fig. 581.

Pitted cells of elder pith.
Magnified 250 diameters.

membrane; but such pores are never originally present; the closure of the pit by the layer of primary membrane may always be demonstrated in young structures; and when orifices really do occur in cell-walls, these arise from the absorption of the primary cell-membrane converting the pit into a pore. The best way of demonstrating that young spotted cell-walls are only pitted and not perforated, is to apply sulphuric acid and iodine for the production of the blue colour in the primary cell-wall.

Simple pits, of no great depth, occur on the slightly thickened walls of most permanent parenchymatous cells; they may be seen in the cells of herbaceous stems, in pith, bark, in the cells of the parenchyma of leaves, &c. (figs. 580, 581; Pl. 38. fig. 14).

In most prosenchymatous wood-cells, or liber-cells, and in the woody cells of the stones or shells of fruits and seeds, the pits are far more clearly evident, and become more and more distinct (Pl. 39. fig. 3) as the layers of thicken g increase in number, since, by the successive application of these, the pits are deepened (with the contraction of the cavity of the cell) until they become canals or tubular passages radiating from the central cavity (Pl. 38. fig. 23). In these cases it is evidently seen that the pits of adjacent cells and ducts correspond to each other at their outer extremity; and in old tissues, when the primary cell-walls have been absorbed, these coincident pits form tubular canals leading from one cell to another. It has been observed that two or more pits sometimes become confluent in the later internal deposits, so that the internally simple orifice leads out to several branches corresponding to the original pits on the wall of the cell. In rare cases, simple pits occur on the outer walls of epidermal cells, as in *Cycas* (Pl. 38. fig. 28).

Pits of the above kinds occur on the structures called ducts (see TISSUES, VEGETABLE), formed of cells applied end to end and confluent (fig. 181, page 259). These large pitted tubes (which occur abundantly in most woods, with the exception of that of the Coniferæ), are sometimes termed *bothrenchyma*, signifying *pitted tissue*; but the character not being exclusively applicable to them, the name is bad.

Fig. 582. Fig. 583.

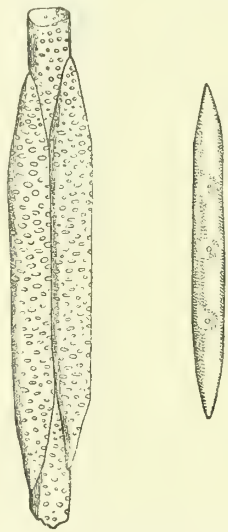
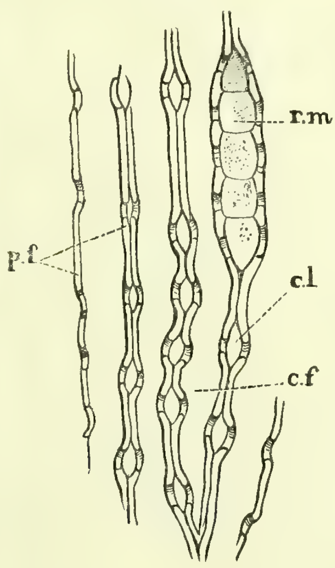


Fig. 582. Pitted ducts of Clematis. Magn. 100 diams.
Fig. 583. Side wall of a cell of Pine, with bordered pits. Magnified 200 diameters.

In many pitted ducts, and in the pitted wood-cells of many plants, especially of the Coniferæ, the pits present a greater degree of complication. The markings on the walls of the wood-cells of most of the Coniferæ, for example, consist of pits surrounded by a broad rim (fig. 583; Pl. 39. figs. 1, 4, 5); the portion within the rim projects somewhat into the cavity of the cell, and appears like a lenticular body attached on the wall; hence the markings were formerly termed the "glands" of Coniferous wood. In reality, however, while the pits themselves resemble ordinary pits, the broad rim, or rather the circular line outside the pit, depends on a condition of the cell-wall outside the membrane, and is merely the outline of a lenti-

Fig. 584.



Section of Pine wood at right angles to the pitted walls. *p. f*, walls of a pitted cell; *c. f*, cavity of a cell; *c. l*, lenticular cavity between two adjacent pits; *r. m*, cells of a medullary ray, the pits have no rim here.

Magnified 400 diameters.

cular cavity existing between two adjacent cells, the boundary of which is visible through the wall on account of the transparency of the latter: the nature of this structure is very evident in sections made at right angles to those which show the bordered pits in face (fig. 584; Pl. 39. fig. 1 *b*). In most of the Coniferæ the wood is exclusively composed of large elongated prosenchymatous cells, with bordered pits of this character on the side-walls (that is, on the walls standing radially or perpendicular to the bark); the pits, however, which lie on parts of the wall adjoining the cells of medullary rays, are generally devoid of the rim.

Similar bordered pits occur very generally on the walls of the pitted ducts of Dicotyledons; but as the wood is here of mixed composition, and the ducts adjoin cells as well as other ducts, independently of the medullary rays, we often find a greater variety of conditions on the wall of the same duct, which may have bordered pits when adjoining another duct, and simple pits, or pits with a double outline, when adjoining cells. The pits with a double outline (Pl. 39. figs. 15 *b*, & 20) are of different nature from the bordered pits (Pl. 39. figs. 13, 14, 15 *a*, 16, 18), the double outline depending simply on the fact that the later or more internal layers of thickening do not reach the edge of the orifice in the earlier secondary deposits, so that the pit is conical, or rather has sloping edges, the circumference at the primary membrane being rather less than that of the margin next the cell cavity. A peculiar modification of this unequal mode of deposit is seen in company with the true rim or border in many cases (Pl. 39. figs. 14, 16, 18), where the central spot or original pit appears in the middle of a slit running across the circle indicating the border; this slit indicates the alteration of the shape of the gap in the secondary deposits in the successive layers, and corresponds to the inner margin of the pit, where this has the form of an elongated groove or slit, gradually diminishing to a small round hole towards the primary cell-membrane (Pl. 39. fig. 18 *a*). Sometimes (Pl. 39. fig. 18 *a*, *b*) the two or more slits formed in this way on contiguous pits become confluent. The last condition indicates a transition to the more sparing form of the secondary deposit where it appears as a modification of a spiral fibre or fibres; and the later secondary deposits of pitted ducts do sometimes actually assume this form, and produce a spiral fibrous layer of thickening inside the layers perforated by pits. This is the case in Taxus (Pl. 39. fig. 4), in the Lime (Pl. 39. fig. 13), and Mezereon (Pl. 39. fig. 19 *b*), &c.

Hartig and Von Mohl have recently described a peculiar kind of pitted tissue formed of cells, which the former calls *Siebröhren*, the latter *clathrate cells*. They are

thin-walled cells occurring associated with the prosenchymatous liber-cells of Dicotyledons, and as forming part of the *vasa propria* of Monocotyledons, having their walls marked with large shallow pits, the membrane of the pits being again very finely punctate or reticulated. Hartig thinks the fine punctations are holes; Von Mohl doubts this; but as the points are not more than 1-1000″ in diameter, it is difficult to decide this question.

For the guidance of microscopic observers, we may furnish a series of examples in addition to the CONIFERÆ (Pl. 39. figs. 1, 4, 5), of different kinds of marking on pitted cells and ducts.

A. *Forms where there is no spiral-fibrous secondary deposit.*

a. Bordered pits uniformly distributed, without reference to adjacent structures: *Eleagnus acuminatus, Clematis Vitalba* (Pl. 39. fig. 18).

b. Bordered pits fewer on the walls adjoining cells: *Acacia lophantha, Sophora japonica.*

c. Bordered pits on the walls adjoining ducts, while the walls adjoining wood-cells have few or no bordered pits, and those next the medullary rays have pits without a border: elder, beech, hazel, poplar, alder, plane, apple, &c.

d. Bordered pits on the walls adjoining ducts, but with large pits devoid of a border where adjoining cells: *Cassytha glabella* (Pl. 39. fig. 14), *Bombax pentandrum* (Pl. 39. fig. 15).

e. A modification of the last, where the bordered pits have the form of slits as wide as the ducts when adjoining ducts, while the walls adjoining cells have large pits without a border: *Chilianthus arboreus* (Pl. 39. fig. 17); the vine (in a less striking manner). *Eryngium maritimum* (Pl. 39. fig. 21) exhibits a condition approaching this.

f. Clathrate cells, large thin-walled cells with round, oval, or elongated thinner places (pits) on their walls, the membrane of the pit being finely reticulated or perforated like a sieve. These are found in the liber of Dicotyledons, as in *Bignonia*, the lime, the vine, elder, pear, &c., and in the central part of the vascular bundles of Monocotyledons, as *Musa, Asparagus*, &c.

B. *Forms where a spiral-fibrous structure is added after the pits.*

g. All the ducts with bordered pits, but the larger ducts with smooth walls, the smaller with a spiral fibre: *Clematis Vitalba, Ulmus campestris, Morus alba.*

h. All the ducts closely pitted, with slender fibres between the rows of pits: *Hakea oleifolia.*

i. The larger ducts with pits, the smaller without; both kinds with spiral fibres on the internal surface: *Daphne Mezereum* (Pl. 39. fig. 19), *Passerina filiformis, Genista canariensis.*

j. The walls adjacent to other ducts pitted, those next cells with very distant pits, or devoid of them; all the walls with fibres: the lime, horse-chestnut, sycamore, cornel, holly, hawthorn, *Prunus Padus, P. virginiana*, &c.

The last set of forms allies these structures to those characterized peculiarly by the SPIRAL-fibrous STRUCTURES; and, as will be indicated there and under SECONDARY DEPOSITS, the smooth layers of thickening, such as those between the pits of *Pinus*, may be made to show a spiral structure by the action of reagents.

For the micro-chemical conditions of these objects, their development and relations, see SECONDARY DEPOSITS; TISSUES, Vegetable; and CELL, Vegetable.

BIBL. Works on Structural Botany, and the *Bibl.* of SPIRAL STRUCTURES.

PLACENTA OF PLANTS.—The region of the carpel whence ovules arise. Stroma would be a preferable term.

PLACODE'I.—A series of Lichenacei.

Char. Thallus crustaceous, squamose, radiate, granulose, powdery, or evanescent.

BIBL. Leighton, *Brit. Lich. Flora.*

PLACO'DIUM.—A genus of Placodei.

Char. Spores polari-bilocular.

BIBL. Leighton, *Brit. Lich Flora*, 175.

PLACOPSILI'NA, D'Orbigny.—*Lituolæ* of irregular growth and attached belong to this subgenus.

BIBL. Carpenter, *Introd. For.* 143.

PLAGIACAN'THA, Claparède.—A genus of Acanthometrina (Rhizopoda).

Char. The spicula, which are branched and without a central canal, do not unite in the centre of the body but on one of the sides, so as to form a scaffolding on which the sarcode rests, pseudopodia elongating either at the ends or sides of the spicula to which they are attached, and which they unite more or less together.

BIBL. Clap. et Lach. *Etudes*, p. 461.

PLAGIOCHI'LA, Nees and Montagne. —A genus of Jungermannieæ (Hepaticæ),

containing a number of British species, viz. *P.* (*Jungermannia*, Hook.) *asplenoides, spinulosa, decipiens, resupinata, undulata, planifolia, nemorosa*, and *umbrosa*, some of which, especially *P. asplenoides* (fig. 585), are among the most frequent and finest plants of the family, its stems growing from 3 to 5″ long.

Fig. 585.

Plagiochila asplenoides. Magnified 2 diameters.

BIBL. Hook. *Brit. Fl.* ii. pt. 1. p. 111, &c.; *Brit. Jung.* pls. 13, 14, &c.; Ekart, *Synops. Jung.* p. 6 *et seq.* pl. 1, &c.; Endlicher, *Gen. Plant.* Supp. 1. No. 473.

PLAGIOG'NATHA, Duj.—This genus of Rotatoria contains species which Ehrenberg included in the genera *Notommata, Diglena*, and *Distemma*. It belongs to Dujardin's Furculariens.

BIBL. Pritchard, *Infus.* 692.

PLAGIOGRAM'MA, Grev.—A genus of Diatomaceæ, family Fragilariæ.

Char. Frustules quadrangular, united into a short fascia; valves with two or more strong, pervious transverse costæ, and moniliform generally interrupted striæ.

BIBL. Greville, *Mic. Trans.* 1865, 1866; Rabenht. *Fl. Eur. Alg.* i. 117; Pritchard, *Infus.* 773.

PLAGIOPH'RYS, Clap.—A genus of Actinophryina (Rhizopoda).

Char. Non-loricated and with numerous pseudopodia, which arise from one particular point of the surface of the body and which are fasciculate. Granular streaming slow on the pseudopodia. Archer has detected a nucleus in a form greatly resembling *P. sphærica.* Fresh water. British and German.

BIBL. Clap. et Lach. *Etudes*, 453; Archer, *Qu. Mic. Jn.* 1871, 146.

PLAGIOT'OMA, Clap. et Lach.—A genus of Bursarina (Infusoria ciliata).

Char. Body not linear although much compressed. A row of buccal cirri in a spiral groove, reaching from the left in front to right and behind. Anus posterior. Syn. *Bursaria*, Ehr.; *Opalina*, Perty, in part. These infusoria are parasitic, and inhabit the intestines of vertebrata and invertebrata, and have been found in the mucus of mollusca and in the intestines of *Lumbricus*. Others live free.

BIBL. Clap. et Lach. *Etudes*, 235.

PLAGIOT'ROPIS, O'Meara.—A genus of Diatomaceæ closely allied to Amphiprora, Ehr.

BIBL. O'Meara, *Qu. Mic. Jn.* 1874, p. 88.

PLANA'RIA, Müll.—A genus of Annuloida, of the order Turbellaria, and suborder Planarida.

Char. Body soft, flattened, oblong or oval, not jointed, covered with vibratile cilia; neither suckers, bristles, nor leg-like appendages present.

Some parts of the structure of these animals have been noticed under ANNULATA in speaking of the Turbellaria. The mouth is situated on the under surface of the middle of the body, at the end of a retractile proboscis; there is no anus; the mouth leads to a capacious stomach, giving off dendritically branched cæca, somewhat as in one joint of a *Tænia* (Pl. 16. fig. 14). Their motion is continuous and gliding, upon water-plants, or the sides of glass jars. The anterior part of the body exhibits a curved row or a single pair of eyes, and sometimes ear-like projections. They multiply by division, and the formation of ova, which are enclosed in a coloured capsule.

The vitelline spheres of the eggs of the *Planariæ* exhibit alternate contractions and dilatations under favourable conditions (Siebold, *Froriep's Notizen*, No. 380, p. 85).

Some of the species are very common in pools, and resemble, at first sight, minute leeches. *P. nigra*, which is black, has a row of marginal anterior eyes, and two lateral and one mesial projection; length about 1-2″. *P. brunnea*, dusky-brown, with a dark mesial line; eyes as above; length rather less. *P. lactea*, cream-coloured, tinged with pale reddish brown, truncate in front, with two slight lateral auricles; eyes two or four; length 1-2 to 3-4″. *P. torva*, grey or black; obtuse in front, angles rounded, centre projecting; eyes two, with a white halo; length 1-2″. Of the other species some are marine.

BIBL. Johnston, *Non-parasitical Worms*; Dugès, *Ann. des Sc. Nat.* 2 sér. xv. and xxi.; Œrsted, *System. Eintheil. d. Plattwürmer*; Diesing, *Syst. Helminth.*; Dalyell, *Powers of Creation*, ii.; Schultz, *Naturg. Turbell.*; Huxley, *Elem. Comp. Anat.*; Vaillant, *Mo. Mic. Jn.* i. p. 311.

PLANARI'OLA, Duj.—A doubtful genus of Infusoria.

P. rubra (Pl. 24. fig. 65). Aquatic, in decomposing vegetable matter; length 1-250″.

BIBL. Duj. *Infus.* p. 568.

PLANORBULI'NA, D'Orb.—A genus of hyaline Foraminifera. Shell spiral, coarsely porous, subnautiloid or outspread, often parasitic; having from 15 to 200 chambers, with single septa and slight rudiments of the canal-system. Aperture sometimes produced and lipped. Complanate (*Pl. mediterranensis*, Pl. 47. fig. 10); plano-convex, *Truncatulina* (*T. lobatula*, Pl. 47. fig. 9); rotaliform (*Pl. Haidingerii*, Pl. 47. fig. 6; *Pl. veneta*, fig. 12); or subnautiloid (*Anomalina* and *Planulina*). Smooth; limbate (*Planulina*); or granulate.

In all seas; fossil in the Lias and later formations.

BIBL. Carpenter, *Introd. For.* p. 206; Parker and Jones, *Phil. Trans.* clv. p. 379.

PLANTA'GO.—The plantain or dock; its leaf and hairs furnish excellent examples of Cyclosis. See Carpenter, *Microscope*, p. 395.

PLANULA'RIA, Defrance.—A noticeable group of delicate, elongate, flattened *Cristellariæ*, connecting the nautiloid with the marginuline varieties, come under this name. Recent and fossil.

BIBL. Parker and Jones, *Ann. Nat. Hist.* 3. v. p. 114 (*crepidula*); xii. p. 215; 4. viii. 166.

PLANULI'NA, D'Orb.—A subgenus of *Planorbulina*; flat, discoidal, subsymmetrical, and with raised margins and septal lines (limbate). Recent and fossil.

BIBL. Carpenter, *Introd. For.* p. 207.

PLAS'TIDS.—The simplest living forms and the most elementary parts of tissues consist of (1) small particles and masses of protoplasm in which there is not a nucleus nor indeed any trace of structure (our protoplasts, 1856), (2) of similar portions of protoplasm in which a nucleus has been differentiated. The first group Häckel terms Cytodes, and the second one cells; and both are grouped under the head of Plastids.

The cytodes, or the protoplasmic masses without a nucleus, are:—

1. *Gymnocytodæ*, or naked cytodes. Such are the freely moving *Monera*, the non-nucleated plasmodia of *Myxomyceta*, and of several other Protista, the amœboid germs of the *Gregarinæ* proceeding from the pseudo-navicellæ, &c.

2. *Lepocytodæ*, or covered cytodes. These are encysted plasma-masses without a nucleus, and enclosed in an entire or incomplete membrane or shell. For example, the encapsuled resting condition of many *Lepomonera*, many *Siphonæa*, and numerous other lower plants, the so-called non-nucleated cells of many higher plants and animal tissues.

The cells or *cyta* are plasma-masses with a nucleus, and are divided into:—

1. *Gymnocyta*, naked cells. Such are the naked plasma-masses with a nucleus, but without a membrane or shell; for example, the true *Amœba*, the naked zoospores of Algæ, the eggs of Siphonophora and other animals, the colourless blood-cells, many nerve-cells, &c.

2. *Lepocyta*, or covered cells. Such are the animals, plants, and cells of tissues with nuclei and cell-walls. See PROTISTA, CYTODE.

BIBL. Häckel, *Biol. Studien*, H. i.; *Qu. Mic. Jn.* 1869, p. 332.

PLAT'INUM.—The sodio-chloride of platinum crystallizes in prisms and plates which polarize light; while the potassio-chloride of platinum yields several forms, which do not polarize light. This reaction of the soda-salt has been proposed as a means of distinguishing soda from potash, or detecting minute quantities of the former.

BIBL. Andrews, *Chem. Gaz.* 1852, x. 378.

PLATYG'RAPHA, Nyl.—A genus of Lichenacei with one species, *P. rimata*, which is found on ash trees, and is rare. It is Welsh and Lusitanian in its habitat.

BIBL. Leighton, *Brit. Lich. Flor.* p. 388.

PLATYS'MA, Hoffm. — A genus of Ramalodei (Lichenacei).

Char. Thallus various in colour, membranaceo-dilatate and lobate. Species numerous, and mostly European and North American.

BIBL. Leighton, *Brit. Lich. Flor.* p. 98.

PLECA'NIUM, Reuss.—*Textilariæ* with sandy shell-tissue come under this heading.

BIBL. Reuss, *Sitzungb. Wien*, xliv. 383.

PLEOPEL'TIS, Humb. and Bonpl.—An exotic genus of Polypodieæ (Polypodioid Ferns), remarkable for the presence of peculiarly formed so-called paraphyses in the sori, performing the function of an indusium. These bodies are peltate, or like minute flat mushrooms or umbrellas expanded over and sheltering the sporanges (figs. 586, 587: see p. 609).

PLEUROCAR'PI.—MOSSES with lateral fruits.

PLEUROCAR'PUS, Al. Braun. — A genus of Zygnemaceæ (Algæ).

The filaments and cells resemble those of

Mesocarpus; conjugation is lateral; but it appears that a prolongation of successive cells on the same filament unites them and develops a zygospore.

BIBL. Rabenh. *Fl. Eur. Alg.* iii. p. 258.

Fig. 586.

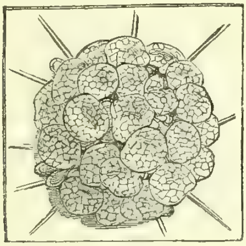
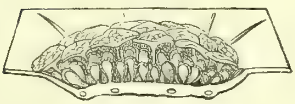


Fig. 587.



Pleopeltis nuda.
Fig. 586. A sorus, seen from above.
Fig. 587. Vertical section of ditto.
Magnified 25 diameters.

PLEUROBRA'CHIA. — A genus of Ctenophoræ (Actinozoa).

The body consists of a transparent sphere, varying, however, from the perfect form in being somewhat oblong, and also by a slight compression on two opposite sides, so as to render its horizontal diameter longer in one direction than in the other. The *Pleurobrachiæ* are so transparent that, with some preparatory explanation of their structure, the most unscientific observer may trace the relation of parts in them. At one end of the sphere is the transverse split that serves them as a mouth; at the opposite pole is a small circumscribed area, in the centre of which is a dark eye-speck. The eight rows of locomotive fringes run from pole to pole, dividing the whole surface of the body like the ribs on a melon. Hanging from either side of the body, a little above the area in which the eye-speck is placed, are two appendages in the shape of long tentacles, possessing wonderful power of extension and contraction. At one moment they may be knotted into a little compact mass no bigger than a pin's head, drawn up close against the side of the body, or hidden within it; and in the next instant they may be floating behind it in various positions to a distance of half a yard and more, putting out at the same time soft plumy fringes along one side, like the beard of a feather. There is no variety of curve or spiral that does not seem to be represented in their evolutions. Sometimes they unfold gradually, creeping out softly and slowly from a state of contraction; or again the little ball, hardly perceptible against the side of the body, drops suddenly to the bottom of the tank in which the animal is floating, and it appears at first sight that it has actually fallen from the body; but soon all the filaments spread out along the side of the thread, it expands to its full length and breadth, and resumes all its graceful evolutions.

BIBL. A. Agassiz, *Sea-side Stud.* Boston, 1871, p. 27.

PLEUROCLA'DIA, Al. Braun. — A genus of Multicellular Algæ, of the group Phæosporeæ. It comprehends the genera ECTOCARPUS, Lyngb., and MESOGLŒA, Ktz., which see.

BIBL. Rabenh. *Fl. Eur. Alg.* iii. p. 393.

PLEUROCOC'CUS, Meneg.—A genus of Palmellaceæ (Unicellular Algæ).

Char. Cells collected in globular or cubical masses, globular or angular from pressure, with a central nucleus. Cystiderm stout, thick, and hyaline. Cell-contents homogeneous, green or reddish. Multiplication by alternate fission in opposite directions. Gonidia formed in particular cells. They present the greatest similarity to the gonidia of Lichens.

BIBL. Meneg. *Nostoch.* p. 38; Nägeli, *Syst.* p. 124; Rabenh. *Fl. Eur. Alg.* iii. p. 24.

PLEURODES'MIUM, Kütz.—A genus of Diatomaceæ, allied to *Striatella*; but the characters given are very obscure. Marine. Africa.

BIBL. Kütz. *Bot. Zeit.* 1846, p. 248; *Sp. Alg.* p. 115.

PLEUROM'ONAS, Perty.—A doubtful genus of Monadina (Infusoria flagellata). It is probably the spore of an Alga or of some cellular plant.

Char. Body reniform, extremely delicate, small, colourless; filaments extended from the concave side of the body, and three times its length.

P. jaculans moves with a jerking motion.

BIBL. Pritchard, *Infus.* p. 502.

PLEURONE'MA, Duj.—A genus of Infusoria, of the family Colpodina.

Char. Body oblong-oval, depressed, with

a broad lateral orifice, from which a bundle of long, curved, floating and contractile ciliary filaments issue.

P. chrysalis (*crassa*), D. (Pl. 24. fig. 66). Aquatic.

BIBL. Duj. *Infus.* p. 473; Clap. et Lach. *Etudes*, p. 274.

PLEUROPH'RYS, Clap.—A genus of Actinophryina (Rhizopoda).

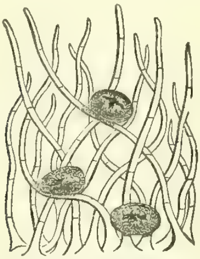
Char. The body is invested with a sheath formed of extraneous siliceous particles united by an organic cement. The sheath is distinctive; otherwise there is the closest resemblance to *Plagiophrys sphærica.*

Freshwater. German.

BIBL. Clap. et Lachm. *Etudes*, p. 454; Archer, *Qu. Mic. Jn.* 1870.

PLEUROPYX'IS, Corda.—A genus of Antennariei (Physomycetous Fungi), grow-

Fig. 588.



Pleuropyxis microsperma.
Magnified 200 diameters.

ing upon leaves and stems. This genus is imperfectly known.

BIBL. Corda, *Icon. Fung.* pl. 6. fig. 291.

PLEUROSIG'MA, Smith. See GYROSIGMA (p. 355).

PLEUROSIPHO'NIA, Ehr.—A genus of Diatomaceæ which is synonymous with *Fragilaria.*

PLEUROSTAU'RUM, Rabenhorst.—A doubtful genus of Diatomaceæ, probably a fasciculate condition of *Stauroneis.* Pfitzer notices the unstriated border, which he says is peculiar.

BIBL. Rabenh. *Fl. Eur. Alg.* i. p. 258; O'Meara, *Qu. Mic. Jn.* 1872, p. 387.

PLEUROTÆ'NIUM, Nägeli.—A genus of Desmidieæ, which includes DOCIDIUM, Bréb., and PENIUM, Kütz., which see.

BIBL. Rabenh. *Fl. Eur. Alg.* iii. p. 140.

PLEUROT'ROCHA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes none; a single tooth in each jaw; foot forked (=*Hydatina* with uniden tate jaws).

P. gibba (Pl. 35. fig. 18). Body ovate-oblong, truncate in front; toes small, turgid. Aquatic; length 1-216″.

BIBL. Ehr. *Infus.* p. 418; Gosse, *Ann. Nat. Hist.* 1851, viii. p. 199.

PLEURO'TUS.—A subgenus of *Agaricus*, belonging to the white-spored series, distinguished by the lateral stem when present. *A. ostreatus* comes into the markets in Hungary in immense quantities, where it is much esteemed. It is not much valued in this country.

BIBL. Fr. *Ep.* p. 129; Berk. *Outl.* p. 134; Cooke, *Handb.* p. 45.

PLEUROX'US, Baird. — A genus of Entomostraca, of the order Cladocera, and family Lynceidæ.

Char. Anterior part of shell prominent above, obliquely truncate below; first pair of legs very large; beak sharp, curved downwards. Aquatic.

1. *P. trigonellus* (Pl. 14. fig. 32). Beak long, sharp-pointed, slightly curved downwards; inferior antennæ short and slender, anterior branch with four setæ, one from the first joint, one from the second, and two from the last; posterior branch with three setæ, all arising from the last joint.

2. *P. uncinatus.* Beak curved upwards at the end; three sharp spines at the anterior inferior angle of the shell; inferior antennæ as the last.

3. *P. hamatus.* Beak blunt and strong, slightly curved downwards; first pair of legs with a curved claw at the end. ? Male of *P. trigonellus.*

BIBL. Baird, *Brit. Entomostr.* p. 134.

PLOCA'MIUM, Lamouroux.—A genus of Delesseriaceæ (Florideous Algæ), containing one species, *P. coccineum*, the commonest of our red sea-weeds, with a delicate flat feathery thallus, from 2 to 12″ high, growing in bushy tufts on rocks or other Algæ. The fruit consists of:—1. *coccidia*, spherical, stalked or sessile tubercles, at the sides or in the axils of the ramules, filled with angular spores; 2. *antheridia*, which occur in inconspicuous flat patches, composed of short erect cells, upon the surface of distinct plants; and 3. *stichidia*, lateral or axillary, simple or branched pods containing a single or double row of linear (transversely planted) tetraspores.

BIBL. Harvey, *Brit. Mar. Alg.* p. 19; *Phyc. Brit.* pl. 44; Grev. *Alg. Brit.* pl. 12; Thuret, *Ann. d. Sc. Nat.* 4 sér. iii. p. 19.

PLŒO'TIA, Duj.—A genus of Infusoria, belonging to the family Thecamonadina.

Char. Body diaphanous, with several longitudinal ribs or keels projecting in the middle, and a rounded perfectly limpid margin. Two anterior locomotive filaments, one flagelliform, the other trailing and capable of arresting the movement of the body.

P. vitrea (Pl. 24. fig. 67). Marine; length 1-1200″. Movement slow.

Bibl. Duj. *Infus.* p. 345; Pritchard, *Infus.* p. 512.

PLŒSCO'NIA, Duj. (Infusoria) = *Euplotes*, Ehr.

PLUMATEL'LA, Lamk.—A genus of freshwater Polyzoa, of the order Hippocrepia, and family Plumatellidæ.

Char. Polypidom confervoid, branched, tubular, branches distinct; tentacular disk crescentic; ova elliptical, with a marginal ring, but no spines.

1. *P. repens.* Polypidom irregularly branched; cells subclavate, without a longitudinal furrow or keel; tentacles about 60; tentacular membrane dentate; ova broad.

α. Adherent throughout.

β. Attached only at the base.

2. *P. fruticosa.* Irregularly branched, attached at the origin only; cells cylindrical, and destitute of furrow, but obscurely keeled; ova elongated.

3. *P. coralloides.* Attached at the base only; tubes dichotomous, densely tufted, destitute of furrow and keel; tentacles about 60; ova broad.

Bibl. Allman, *Freshw. Polyz.* 92; *Ann. Nat. Hist.* 1844, xiii. 330; Johnston, *Brit. Zooph.* 402; Parfitt, *Ann. Nat. Hist.* 1866, xviii. p. 171.

PLUMULA'RIA, Lamk.—A genus of Hydroida, and family Plumulariidæ.

Char. Zoophyte consisting of plumose shoots attached by a creeping stolon. Hydrothecæ cup-shaped; nematophores along the stem and branches; gonothecæ unenclosed, differing in the two sexes, scattered.

Eight British species.

P. pinnata, Linn. Stem a simple tube, plumose; pinnæ alternate, three on each internode; cells rather distant, campanulate, appressed, rim entire; vesicles pear-shaped, rim toothed.

P. setacea, Ellis. Stem a single tube, pinnate; pinnæ alternate, one at each joint; joints ringed; cells very remote, campanulate, rim even; vesicles elliptical, smooth. Common.

Bibl. Johnston, *Brit. Zooph.* 89; Hincks, *Brit. Hyd. Zooph.* i. p. 294.

PLUMULARI'IDÆ. — A family of Hydroida.

Bibl. Hincks, *Br. Hyd. Zooph.* i. p. 279.

PODAXINE'I.—A family of Gasteromycetous Fungi, none of which are found in Britain; they are distinguished from all allied tribes by a solid column in the centre of the sporange.

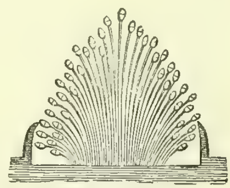
Many of the species grow on the hills of the White Ant.

Bibl. Montagne, *Ann. des Sc. Nat.* 2 sér. xx. 69; Tulasne, *Ann. des Sc. Nat.* 3 sér. iv. 169; Currey, *Linn. Trans.* xxvi. p. 288.

PODISO'MA, Link.—A genus of Uredinei (Coniomycetous Fungi), growing upon

Fig. 589.

Fig. 590.



Podisoma Juniperi.

Fig. 589. Branch of Juniper with clavate fructification protruded from beneath the bark. Nat. size.

Fig. 590. Vertical section through a fruit, showing the filaments terminating in bilocular spores. Magnified 50 diameters.

the living leaves and branches of species of Juniper; the filamentous mycelium creeping beneath the epidermis, and sending up a fleshy, stalk-like, tremelloid body (fig. 589), composed of agglutinated filaments (fig. 590) terminating in bilocular spores (or two spores adherent together), each of the cells having two or four pores, through which the internal membrane is protruded in germination.

It has been supposed, but perhaps without sufficient grounds, that the *Podisoma* of Savine is a condition of *Rostelia cancellata.*

PODOCOR'YNE, Sars (in part). — A genus of Podocorynidæ (Hydroida).

Char. Cœnosarc a network of creeping fibres, with a polypary forming a cup-like investment round the base of the polypites. Polypites sessile, claviform. Gonophores borne on the body of the polypite below the tentacles or on the common basis, and originating free medusiform zooids. Go-

nozooid: umbrella bell-shaped; manubrium shorter than the umbrella, four-lipped, each lobe bearing a tuft of vibratile thread-cells; radiating canals 4; marginal tentacles springing singly from bulbs without ocelli; the first set placed at the termination of the canals.

The genus *Dysmorphosa*, Philippi, is included in *Podocoryne*. The budding from the manubrium or proboscis of the medusoid is well seen in *Podocoryne*. A. Agassiz writes:—"One of our most common little jelly-fishes, the *Dysmorphosa*, to which we owe the occasional blue phosphorescence of the sea, so brilliant at times, buds in this manner." Buds appear on the proboscis and enlarge with it. The elder buds soon drop off, to be succeeded by others; and moreover there is a constant succession. It takes but a few days for each bud to be developed into a budding Medusa; and hence their vast multitudes.

Bibl. Sars, *Faun. Litt. Norv.* pp. i, 4, t. i.; Allman, *Ann. N. Hist.* 1859, 1864; Hincks, *Brit. Hyd. Zooph.* 27; A. Agassiz, *Sea-side Studies*, Boston, 1871.

PODOCORYN'IDÆ.—A family of Hydroida.

Char. Polypites sessile, with a single verticil of filiform tentacula round the base of a conical proboscis.

Bibl. Hincks, *Brit. Hyd. Zooph.* p. 27.

PODOCYS'TIS, Ktz.—A genus of Diatomaceæ, Cohort Surirelleæ.

Char. Frustules sessile, cuneate; valves convex, obovate, with a median line, transverse continuous, and intermediate granular striæ.

P. americana, Bailey (Pl. 42. fig. 21). The only species; marine = *P. adriatica*, Ktz. = *Doryphora elegans*, Roper.

Bibl. Bailey, *Smith. Contrib.* 1854; Ktz. *Bac.* p. 62. t. 7; Roper, *Mic. Jn.* ii. p. 284; Rabenht. *Fl. Eur. Alg.* i. p. 60.

PODOCYS'TIS, Lév. = *Melampsora*. See Uredinei.

PODODIS'CUS, Kg.—A genus of Diatomaceæ.

Char. Frustules single or concatenate, with a marginal stalk; valves circular, convex. Marine.

No markings visible under ordinary illumination.

P. jamaicensis (Pl. 13. fig. 16). Stalk elongate, weak. Diameter 1-840".

Bibl. Kütz. *Bacill.* p. 51; *Sp. Alg.* p. 26.

PODOPH'RYA, Ehr.—A genus of Acinetina (Infusoria).

Char. Suckers neither on a trunk nor ramified; body without a sheath, but pedunculated. *P. fixa* (Pl. 23. fig. 5, *a* & *b*).

Bibl. Ehr. *Infus.* p. 305; Clap. et Lach. *Etudes*, 381; *Reprod. des Acin.* 108.

PODOSI'RA, Ehr.—A genus of Diatomaceæ.

Char. Frustules concatenate, with a lateral stalk; valves circular, punctate, convex. Marine.

Stalk attached to the centre of the valves.

P. hormoides (Pl. 14. fig. 34). Diameter 1-650".

P. Montagnei (*Melosira globifera*, Ralfs). Diameter 1-600".

P. maculata, Smith, *Diat.*

P. compressa, W. & A.

P. lævis, Gregory.

Bibl. Kütz. *Sp. Alg.* p. 26; Smith, *Brit. Diat.* ii. 53; Rabenht. *Fl. Eur. Alg.* i. p. 37.

PODOSPHE'NIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules attached, sessile, wedge-shaped in front view; ends indented so as to produce a black line (vitta) in the front view; valves convex, obovate, with a longitudinal median line and transverse striæ, but no nodules. Marine.

The striæ consist of rows of dots, sometimes distinct by ordinary illumination, at others not so.

P. Ehrenbergii (Pl. 13. fig. 17). Length 1-240".

P. Lyngbyei. Length 1-350".

Bibl. Smith, *Brit. Diat.* i. p. 82; Kütz. *Bacill.* p. 119; *Sp. Alg.* p. 110.

PODOSPO'RIUM, Lév. = *Melampsora*. See Uredinei.

PODOS'TOMA, Clap. et Lach.—A genus of Amœbina (Rhizopoda).

Char. An Amœba with nucleus and one contractile vesicle with two kinds of pseudopodia, one for locomotion and the other for nutrition. Fresh water near Berlin.

Bibl. Clap. et Lach. *Etudes*, 441.

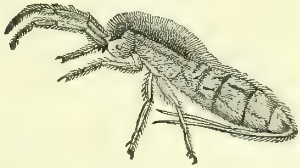
PODU'RA, L.—A genus of Insects, of the order Thysanura, and family Podurellæ.

This genus has been greatly subdivided. In its extended signification, the characters consist in the thorax being distinct from the abdomen, and in the presence of a forked tail, bent under the abdomen when not in use, and enabling the animals to move by springing or jumping, whence the common name of springtails applied to them.

They are of a leaden appearance, and found in shady damp places, as under flowerpots or stones, in cellars, &c., and are about

1-20 to 1-10″ in length. They may be caught by placing a little flour upon a piece of paper in their haunts.

Fig. 591.



Podura.
Magnified about 15 diameters.

The body is covered with scales (Pl. 1. fig. 12), which are used as test-objects. Those of *P. plumbea*, the so-called common springtail, are usually recommended; but we believe that the most common *Podura* is not this species. This is, however, a matter of little importance, because the scales of several species, belonging to even different genera, are exactly similar, both in form and markings.

See Scales of Insects and Test-Objects.

Bibl. Gervais, *Walckenaer's Aptères*, iii. and the *Bibl.* therein; M'Intire, *Mo. Mic. Jn.* i. p. 203; 1870, p. 1; Beck, *Mic. Trans.* 1862, p. 84; Lubbock, *Trans. Linn. Soc.* xxiii. 429 & 589.

POLAR'ISCOPE.—A term employed to designate a polarizing apparatus, consisting of a polarizer and analyzer. See Introduction, p. xviii.

POLARIZATION OF LIGHT.—The phenomena exhibited by microscopic objects, when viewed by polarized light, are perhaps the most beautiful and interesting of those connected with the use of the microscope. The extreme brilliancy, transparency and variety in the colours developed cannot be equalled, much less can they be represented by illustrations, although the figures in Pl. 31 may give some idea of the manner in which they are arranged in certain objects.

The ordinary arrangement of the parts of the polarizing apparatus scarcely needs description,—the polarizer being placed beneath the object and the analyzer above it, the polarizer and analyzer usually consisting of two Nicol's prisms, or two plates of tourmaline. Some artificially prepared crystals exert a powerful polarizing action, and may be used either as polarizers or analyzers, or as both; among these the salt of Quinine called Herapathite occupies the first place. Others form interesting analyzers, some of which have been noticed under Analytic Crystals and Dichroism.

Numerous salts and other crystalline bodies, which powerfully depolarize the already polarized light, and exhibit beautiful colours, are mentioned under their respective heads; some of these may be enumerated here—as the oxalate of ammonia, of soda, and of chromium and ammonia, the oxalurate of ammonia, the acetate of copper, chlorate of potash, the prismatic form of the ammonio-phosphate of magnesia, the ammonio-phosphate of soda, the sulphates of cadmium and of magnesia, selenite, salicine, uric acid, &c.

Many animal bodies and tissues also possess considerable depolarizing power—as horse-hair, portions of feathers, sections of quill, of hoof, horn, &c.

The influence of vegetable structures on polarized light has been long known, but only recently thoroughly investigated, by Von Mohl, whose interesting account we are able to confirm; and a brief notice of it is desirable here. In a communication with which he has favoured us, he recommends the following arrangements as most convenient. As it is desirable to obtain as much light as possible, a glass prism is preferable to the ordinary mirror for illumination; Nicol's prisms are preferable to tourmaline or Herapathite for the polarizer and analyzer; and the latter should be as large as possible. Further, the light emerging from the polarizer should, if possible, be condensed by an achromatic of large aperture; or the condensation may be effected by a hemispherical flint-glass lens, 5 lines in diameter, having its plane face turned towards the object. The objectives must be of large angular aperture: a power of 4-10″ is sufficient for most objects; but 1-4″, and even 1-8″ objectives may be made to transmit sufficient light. It is requisite to provide plates of the doubly-refracting substances mica and gypsum, mounted so that they can be inserted between the polarizer and the condenser, and revolved horizontally while so placed. Those of mica are used for detecting weak degrees of doubly-refracting power, being of such thickness as to give a grey field with a white or black object when the prisms cross. The thin laminæ, of which six may be provided, from the thinnest possible up to 1-20‴,

should be cemented with Canada balsam between glass plates. For obtaining colours, plates of gypsum, similarly mounted, are best. Von Mohl prefers such as give a red field, and provides plates of different thickness, giving the reds of the different orders of Newton's rings.

It is easy to ascertain whether an organic body shows positive or negative colours, by comparing its colour, when seen with a plate of gypsum in a certain definite position, with the colour given under the same circumstances by a strip of glass brought into a state of tension by slight bending, or with the colours of a suddenly-cooled globule of glass. In this way the author determined that the fibres of a spiral vessel displayed negative colours, and the laminæ of a starch-corpuscle positive colours, and then applied these organic structures, by comparison, for ascertaining the properties of other objects. The objects to be examined should be mounted in a liquid or other substance rendering them as transparent as possible, such as concentrated glycerine, Canada balsam, or an essential oil.

When ordinary globular or cylindrical cellular tissues are viewed by cross sections, their substance is seen to be doubly refractive; for when the prisms cross, the circular sections of the cell-walls appear like rings of bright light on a black ground, but with the ring divided into four quadrants by dark stripes, as if a black cross lay over it; when the prisms are placed parallel, the parts of the section previously bright appear dark, and *vice versâ*, on a bright field. If a section of polyhedral cellular tissue is viewed in the same way, the appearances are somewhat different, since the cut edges are here straight lines, variously inclined towards the prisms; those which are perpendicular to the prisms are invisible, while those standing obliquely are bright in their whole length. In general, cell-membrane acts the more powerfully on the light the denser its substance, and soft collenchymatous tissues are far less powerfully doubly-refractive than wood-cells. When the cells have the walls much thickened, it is common for the primary cell-membrane to be much more powerfully refractive than the secondary layers. The influence of cellulose membranes upon polarized light is not much affected by bleaching them with nitric acid and chlorate of potash (Schultze's reagent). It has been supposed that the remarkable effect produced by the epidermis of *Equisetum hyemale* is attributable to the silex there present; but Mohl finds the action greatly weakened by destroying the organic matter by a red heat. But this heating does not remove the power there, nor in the Diatomaceæ, of which Mohl confirms Bailey's statement, in contradiction to Ehrenberg, that various species of *Navicula, Synedra, Pleurosigma*, and *Melosira* are decidedly doubly refractive.

Very remarkable phenomena are produced when the polarized light is made to pass through plates of mica or selenite. In the first place, thin plates of mica often allow of the discovery of a doubly-refracting power too feeble to be detected by the prisms alone—the degree of illumination of the object being slightly different from that of the field on which it is viewed. But the most important matter is the revelation, by the use of the selenite plates, of the existence of positive and negative characters, like those of positive and negative crystals, in the chemically distinct constituents of vegetable tissues.

Let us suppose that between the lower prism and the object is placed a plate of selenite giving a red field; the plate is then rotated so that its neutral axes are at an angle of 45° with the prisms. A section of a cylindrical vegetable cell will be seen to be divided into four quadrants: the two alternate quadrants, whose middle lines correspond to the neutral axes of the selenite, are either blue or green, the other two yellow or red: if the selenite is then rotated so that its neutral axes are perpendicular to the prisms, the colours will be all lost; but on continuing the rotation, they reappear in the reverse order—what was blue appearing yellow, and *vice versâ*. When the walls are rectilinear, all the cell-walls perpendicular to one of the prisms will give the colour of the field, all those which run parallel with one of the neutral axes of the selenite plate, or form no great angle with it, will be blue, those parallel with the other axis yellow.

It is found that vegetable structures fall into two classes in reference to these colours, in one of which classes all layers lying obliquely in the direction of a right-wound screw are tinged blue and yellow, those oblique in the opposite direction yellow or red; in the other class, the colours under the same conditions are just the reverse; so that one class are optically positive, the other optically negative.

The optically negative are the ordinary

cell-membranes of the internal organs of plants, whether in their natural condition or cellulose purified by the help of nitric acid and chlorate of potash: collenchyma, horny endosperm-cells, the gelatinous cells of Algæ, &c., all agree in this property. Optically positive colours are given by cell-membranes of periderm and the cuticular layers of epidermal cells. The contrast of the positive and negative colours of the cuticle and other parts of the cell-wall is well seen in the epidermis of *Aloe*. The diversity of colouring under polarized light here corresponds to the diverse behaviour under treatment with iodine after maceration in solution of potash (SECONDARY DEPOSITS).

The longitudinal sections of all behave like the cross sections; but the appearances are not so clear. When side views of the surface of cells are obtained, the phenomena are very varied; but these are best seen in vessels or ducts when the thickening layers are in the form of spiral bands. Thus, if one of the spiral vessels of *Musa* is placed (its spiral somewhat drawn apart) with its long axis perpendicular to one of the prisms, the fibres on the upper side turn to the left, those on the underside towards the right; and when the selenite plate is interposed, they exhibit the complementary colours. When the side walls of cells have obscure striation, as in the cells of Conifers, the liber-cells of Apocyneæ, &c., the membrane gives evidence of its fibrillar structure by the yellow or blue colour developed with the selenite plate. If fibres of a spiral vessel cross at right angles, and they are pressed together, they neutralize one another where they cross: when the prisms are used alone, the crossing points are black, the rest of the fibres white; when the selenite plate is interposed, the crossing points exhibit the colour of the field, and the uncrossed portions of the fibre are blue or yellow according to position.

The vicinity of a round bordered pit, as in the wood-cells of *Pinus*, exhibits a black cross when seen perpendicularly by polarized light. The black cross and the colours exhibited by starch are well known. Chlorophyll does not seem to act on polarized light, nor the primordial utricle of cells, except a trace when contracted by weak alcohol.

The polarization apparatus is exceedingly useful for the detection of crystals (RAPHIDES) in vegetable tissues, when they are so small as to be easily overlooked, and the larger kinds form beautiful objects with, and often without the selenite plate. See MUSCLE.

BIBL. Herschel, *Encycl. Metropol.* art. *Light*; Pereira, *Lectures on Polarized Light, by B. Powell*; Brewster, *Optics*; Erlach, *Mik. Beobacht. üb. organ. Element. bei polar. Licht, Müller's Archiv*, 1847; Valentin, *D. Untersuch. &c.* 1861; Lobb, *Qu. Mic. Jn.* viii. p. 107; Carpenter, *The Microscope*; Beale, *How to Work, &c.*

POLLEN.—This name is applied to the coloured pulverulent substance familiar to every one as occurring scattered in the interior of full-blown flowers; it is produced in the anthers, the (usually) stalked club-shaped organs which stand in one or more circles between the floral envelopes and the pistils, and is discharged from them when ripe, in order to fertilize the ovules. When slightly magnified, the pollen of most flowers appears to consist of granules, of different size and colour in different plants; hence the individual particles are called *pollen-grains* or *granules* (Pl. 32). Examination under a sufficient magnifying power shows that the simple or typical forms of pollen-grains are single free cells filled with fluid matter: more complex forms occur in many cases, which, however, may be simply characterized as simple pollen-grains, permanently coherent into definitely-formed groups.

The pollen-grain may be examined as to its form and structure, its contents, and its development.

The forms of simple grains presented in different plants are tolerably varied—spherical (Pl. 32. figs. 8–10, 22, 23, 25) and elliptical (figs. 6, 11, 29) being perhaps those most common; but besides these, numerous geometrical forms occur, such as tetrahedral (fig. 14), polygonal (figs. 16, 27, 28), cubic (fig. 19). But it must be noted here that the forms frequently vary according as the pollen is viewed dry or in fluid, since the elliptical and allied forms often expand into a spherical form, when they absorb liquid (figs. 18 & 20 *a*, *b*, *c*). The explanation of this will be given presently. The external appearance is further greatly influenced by minor peculiarities of form, such as ridges, spines and processes of different kinds; these, however, are referable to the structure of the outer coat.

The ordinary structure of the coats or the cell-wall of the pollen-grain is that of a delicate internal cell-membrane, with an

outer, thick and resisting layer, which may be regarded as the CUTICLE of the inner or proper membrane of the cell. In a few cases the inner membrane alone exists, as in the cylindrical pollen-cells of *Zostera* and some other aquatic plants. In other cases the outer or cuticular coat presents a more complex structure, and two, or, it is said, even three layers may be distinguished in it; these, however, seem to be merely a lamination of the outer coat. The conditions in some of the Coniferæ are different from this, and will be alluded to presently. The inner membrane is exceedingly delicate and homogeneous: in ordinary spherical or oval grains it accurately lines the outer coat; in some of those forms which present processes of various kinds, such as *Œnothera*, it seems to us that the inner coat does not extend into these processes in the mature pollen. The outer coat exhibits, as to surface, every variety of appearance, from smooth, through granular and spiny, to pseudo-cellular arising from reticulated ridges; in addition to this, the processes just alluded to give a very peculiar aspect to many kinds of pollen. Besides these, we find in all cases markings appearing like *pores*, or others like *slits* (which become *furrows* when dry), or both together, and these in varying number in different cases. The colour of the pollen presents great differences; although usually yellow, it may be whitish, red (*Verbascum*), blue (*Epilobium angustifolium*), even black (tulip): this colour resides in the outer coat. The outer coat also exhibits, in the majority of cases, a secretion upon its surface, of a viscid character, usually described as oily, but apparently consisting of a viscid matter not readily soluble in water, remaining from the dissolved parent cells. It would seem to be the substance which holds together the pollen-grains in those cases where it consists of waxy masses, readily breaking up into small fragments (Ophrydeous Orchids). In the Onagraceæ the pollen-grains are loosely connected by slender viscid filaments, which appear to derived from the same source.

The more detailed explanation of the character of the pores &c., the projecting processes, and the compound conditions of pollen will be understood better after a sketch of its development.

The anther, in which the pollen is formed, consists in its younger stages of a minute, solid, cellular papilla or cylindrical body; at an early period a distinction becomes manifest in its cells: a single vertical row, lying in the position of the axis of each pollen-chamber (or loculus), presents a different aspect, from its cells exceeding the surrounding ones in size; and these rows undergo a special development to produce the pollen-grains, while the surrounding layers are developed into the tissues forming the coat or wall of the anther, and its mid-

Fig. 592.

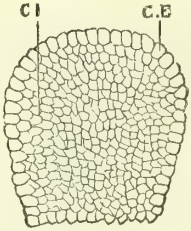


Fig. 593.

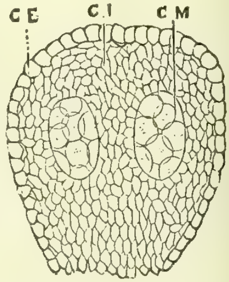
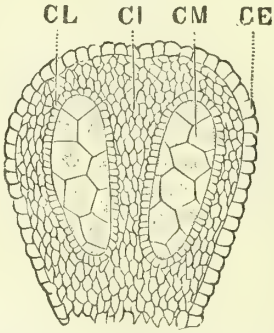


Fig. 594.



Vertical sections of a cell of a young anther of the Melon, showing the gradual separation of the regions. *CE*, epidermal cells; *CI*, cells of the wall of the anther; *CL*, cells lining the loculi; *CM*, cells from which the pollen is developed.

Magnified 100 diameters.

rib or *connective* (see ANTHER). The cells of the primary row multiply by cell-division with the general increase in size of the anther (figs. 592–594), until at length they form relatively large masses of cellular tissue composed of large squarish cells filled with granular contents, well defined as constituting a distinct tissue from the walls of the pollen-chambers. A new change then takes place; the contents of each cell secrete a layer of cellulose, which

does not adhere to the wall of the parent cell to form a layer of secondary deposit, but lies free against it, so that a new free cell is formed within each old one, nearly filling it. The walls of the old cell (forming a connected parenchymatous tissue) then dissolve, so that the new cells become free, no longer merely in their parent cells, but in a cavity which is to constitute the pollen-chamber or loculus of the anther. These free cells are the *parent cells of the pollen* of authors. A new phenomenon soon occurs in these. These parent cells divide into four by ordinary cell-division, either by one or by two successive partings by septa at right angles to each other but both perpendicular to an imaginary axis (as when an orange is quartered), or by simultaneously-formed septa which cut off portions in such a manner that the new cells stand in the position of four cannon-balls piled into a pyramid (tetrahedrally). These new cells are the *special parent cells* of the pollen; and in each of these the entire protoplasmic contents secrete a series of layers, which in the ordinary course, by the solution of the primary walls of the special

Fig. 595.

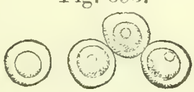


Fig. 596.

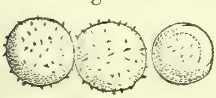


Fig. 597.

Pollen-grain of the Meion in various stages of development.

Magnified 100 diameters.

parent cells upon which they were applied, become the walls of free cells, which constitute the simple ordinary pollen-cells. These subsequently increase in size; and their outer laminæ assume the characteristic form and appearance while free in the chamber of the anther (figs. 595–597).

In referring the peculiarities of many kinds of pollen to circumstances connected with the development, it may be noted, in the first place, that the mode of division of the parent cells into quarters often influences the ultimate form of the pollen-grain: thus, when the division is by two planes at right angles, the original form of the pollen-grain will be elongated, and the ripe grain will probably be elliptical, while, when the division is "tetrahedral," the grains may retain the form thus produced, or be slightly modified and become polygonal, or, as is more common, they expand more readily than the others into a sphere. But there is no absolute rule here; we find even the tetrahedral and the polar division occur together among the parent cells of the same anther. In the next place, a compound condition of the pollen-grains (Pl. 32. figs. 7, 17) is readily explicable by referring it to an arrest of the process of subdivision; so that if the walls of the special parent cell do not dissolve, the pollen-grains will be left in groups of four; and if the parent cells do not become singly detached in the antecedent process of solution, the grains may be still developed in the same order and manner, and remain connected in greater or smaller masses or groups, each enclosed in its special parent cell, itself connected with a number of others of the same generation by the persistence of the walls of the cells in which the parent cells were developed. This explains the compound pollen of the Acacias (Pl. 32. fig. 27), and, as an excessive form, the waxy pollen-masses which occur in the Orchidaceæ and Asclepiadaceæ. It is sometimes stated that the pollen-grains of these compound forms are merely connected together by the viscid substance remaining from the solution of the parent cells; but this would render such cohesions indefinite in character, instead of being regular; at the same time it will be understood that the solution may have advanced so far that the grains merely hold together slightly, and may readily be separated. This is not the case, however, with the majority of compound pollen-grains. When pollen-grains do become free, the viscidity of their surface is probably referable to the dissolved parent cells.

The metamorphoses of the outer coat or cuticle of the pollen-grain are very remarkable, and not yet at all understood; the granulations (Pl. 32. figs. 11, 12), spines (figs. 8, 9, 22, 26), reticulations (figs. 13, 23, 27, 28), &c. characterizing mature grains make their appearance in the interval between the solution of the special parent cells and the bursting of the anther, while the pollen-grains lie free within the latter; their production is accompanied by a general growth and expansion of the pollen-grain. We have observed that the outer

coat is often deposited as a very thick layer inside the special parent cell, and that, when the latter dissolves, the outer coat of the pollen-grain is also in a softened condition, and becomes stretched by the expanding inner coat, finally forming a comparatively thin layer on the ripe grain (*e. g.* in *Tradescantia*). The mode of origin of the markings, like those on SPORES and on the cuticle of *Helleborus* &c. (see EPIDERMIS), is altogether unknown; probably all the cases are referable to one cause.

It has been mentioned that the mature pollen-grain exhibits pores or slits. We believe they should rather be regarded as *thinner* places in the outer membrane. Their number and position varies much, as will be indicated presently on referring to some of the principal types of form of pollen. The slit-like markings are generally accompanied by a peculiar shrinking of the pollen when dry, the coat collapsing at the thin places, so that grains of this kind appear oval or angular, not clearly exhibiting the slits (which then become *furrows*); but they swell out and display the latter clearly when placed in water or dilute acids (Pl. 32. figs. 18 & 20). When the so-called pores exist, they are either like simple pores (Pl. 32. fig. 10), or they may be provided with little disk-like pieces or lids, which fall off and leave them bare when the pollen-tube is formed (figs. 13 & 22). In all cases, however, we believe that the outer coat is extended over the whole surface, and that the slits and dots are merely thinner places; moreover, in certain cases (*Leschenaultia*, a quaternate pollen) we have seen the thickening layers of the young pollen-grain, inside the parent cell, exhibit *pits* (exactly comparable to those of ordinary pitted cells) at the places corresponding to the future pores, and, curiously enough, in some cases at least, the pits of adjacent pollen-cells corresponding, although in the mature expanded compound grains they were far separated. Sometimes the lids are found at the end of short projecting processes (Pl. 32. fig. 22). The pollen of *Œnothera* and allied genera exhibit remarkable conditions, which have been mistakenly described. The form of the grain is that of a depressed sphere with three large equidistant truncated cones projecting pretty nearly in the same plane. The outer coat is thick, except at the ends of the conical masses; and two laminæ are distinguishable (Pl. 32. fig. 14). The outer coat thins off towards the end of each process. It appears to us that the inner coat or true pollen-membrane does not extend into the processes at all, but is globular, and that a semifluid deposit occupies the space between the inner coat and the outer, in the cavity of the tubular processes. Now, supposing such a deposit to become hardened and, after circumscissile fission, pushed off as a plate by the advancing pollen-tube, instead of giving way and expanding, we should have the lid occurring in *Cucurbita Pepo* (Pl. 32. fig. 22) and other cases.

In *Mimulus moschatus* (Pl. 32. fig. 24) the slits or furrows are curved, and in *Nymphæa*, *Pinus*, and other cases still more complex.

It has been stated that the pollen is the agent of fertilization of the ovules in the Flowering plants. When scattered from the anthers, that portion of the pollen which falls upon the stigma (and frequently other portions falling upon nectaries or secreting surfaces) swell slightly, and germinate, as it were, sending out a delicate tubular process from one or more of the so-called pores or slits (Pl. 32. fig. 30), which processes (the *pollen-tubes*) insinuate themselves between the loosely packed cells of the stigma, and, continually elongating, make their way down the style and along the *conducting tissue* to the ovules. In the Coniferæ the pollen-grains fall directly upon the micropyle of the naked OVULE, and send their pollen-tubes into it. The pollen-tube is produced by the development of the inner or proper coat of the pollen into a tubular filament. When pollen-grains are placed in dilute sulphuric acid or in syrup (sometimes in water), they absorb liquid, swell, and their contents partly exude from pores &c., either to a slight extent, as a little "hernia," as it were, of the inner membrane, or in large quantity in a worm-like, irregular mass; in the latter case the coagulation of the surface often produces a pellicular coat. These exuded masses are of course distinct from the true pollen-tubes produced under natural conditions.

The fluid contents of the pollen-grains consist of a granular viscid protoplasm, with minute starch-granules and (apaprently) oil-drops, making together what has been called the *fovilla*, which increases in density as the pollen ripens. The starch-granules exhibit molecular motion in the pollen-tube, and still more clearly when they escape by rupture. The granular contents

of the pollen-cell, which are always rendered opaque by the action of water, are gradually transferred to the pollen-tube as it elongates.

Connected with this point is the peculiarity exhibited by the pollen of the Coniferæ. In the Abietineæ the form of the granules is very peculiar—elongated, curved, and with bulging ends; and, according to Schacht, a distinct internal cell exists, attached at one side in the cavity of the ordinary pollen-cell, this internal cell dividing and growing out as the pollen-tube when the pollen-grain comes upon the ovule. The pollen of the Cupressineæ is spheroidal; but free cellules appear to be formed in the pollen-tubes during the fertilization. These conditions, which are not yet satisfactorily cleared up, indicate a relation to the spermatozoid-producing spores of the Marsileaceæ, &c., analogous to that between the Gymnospermous ovules and the ovule-spores of those Cryptogamic families.

It has been imagined that the form and structure of the pollen-grains might have some relation to the general structure of the plants, and might serve as an indication of systematic position and affinities. But there appears to be no definite relation; very varied pollen occurs within the limits of the same family, and very similar pollen-grains in families widely distant. There appears, however, to be a certain relation within the limits of *genera*. It may be perhaps generally stated that the Monocotyledons have frequently one pore or furrow; the Grasses often three pores, as is the case with many Dicotyledons, many of which have more, while a large number of the families of the latter division exhibit both pores and slits. As microscopic objects, it is most convenient to class the forms artificially, or according to structure; and we give a brief list of the principal varieties arranged under this point of view.

The pollen-grains of *Zostera*, *Zanichellia*, and other submerged aquatic plants, have no cuticle or outer coat; all other known forms possess one or more outer layers.

A. Outer coat without furrows or pores.

a. Outer coat granular: *Strelitzia Reginæ*, *Calla palustris*, *Crocus sativus*, *&c.*, *Asarum europæum*, *Laurus nobilis*, *&c.*, many Euphorbiaceæ.

b. Outer coat with papillæ: *Canna indica.*

c. Outer coat with cell-like reticulations: *Ruellia formosa* (Pl. 32. fig. 23) *R.*, *strepens*, *Tribulus terrestris.*

In *Periploca græca* (Pl. 32. fig. 15) and *Apocynum venetum* (fig. 7) grains of this kind are connected in fours in one plane; in some *Luzulæ* tetrahedrally.

B. Outer coat presenting longitudinal furrows (or folds).

* One furrow (the form of most Monocotyledons).

a. Outer coat finely granular: common in Monocotyledons; among the Dicotyledons, in *Myrica cerifera*, *Magnolia grandiflora*, *Liriodendron tulipiferum*, *&c.*

b. Outer coat granular, spiny: *Nymphæa alba.*

c. Outer coat with cell-like reticulations: *Hemerocallis fulva*, and other Monocotyledons.

d. Outer coat with irregular reticulations: *Alstrœmeria Curtisiana.*

Among the Orchideæ are found quaternate grains belonging to this group.

** Outer coat with two furrows: a rare form, occurring in species of *Pontederia* and *Amaryllis*, *Tamus communis* and *elephantipes*, *Tigridia pavonia*, *Calycanthus floridus*, *&c.*

*** Outer coat with three longitudinal furrows.

a. Outer coat granular. One of the commonest forms: *Quercus Robur*, *Viola odorata* (Pl. 32. fig. 6).

b. Outer coat with short spines: *Cactus flagelliformis*, *Viscum album.*

c. Outer coat with cell-like reticulations: *Statice* (Pl. 32. fig. 29), various Cruciferæ.

**** Outer coat with more than three furrows.

a. Four: very rare as normal, *Houstonia cærulea*, *Cedrela odorata*; occasionally occurring where three is the normal number, as in *Solanum tuberosum.*

b. Six: some of the Labiatæ and Passifloreæ (Pl. 32. fig. 20), *Ephedra distachya*, *Heliotropium grandiflorum.*

c. A large number of furrows: many Rubiaceæ, e. g. *Sherardia arvensis* (Pl. 32. fig. 18).

The pollen of the Pines is related to this group, also that of *Nymphæa Lotus*, *Victoria regia*, and other plants, where the furrows or thin places occupy the greater part of the wall, and the outer coat forms only segmental pieces. In *Mimulus moschatus* (Pl. 32. fig. 24) a very remarkable appearance arises from the furrows running in a curved or spiral direction; and analogous conditions are met with in *Thunbergia alata*.

C. Outer coat with pores.

* A single pore: Grasses, Sedges, *Typha angustifolia*, *Sparganium ramosum*.

** Two pores: *Colchicum*, and a few other Monocotyledons; also *Broussonetia*.

*** Three pores.

a. Outer coat granular: Dipsaceæ, Urticaceæ, Onagraceæ (here the pores form projecting processes (Pl. 32. fig. 14); and in *Morinda persica* this is still more the case); *Cucumis sativus*.

b. Outer coat with cell-like reticulations: many Passifloreæ (with large lids, *P. cærulea* (Pl. 32. fig. 13), *alata*, *&c.*).

**** Four pores.

a. Pores on the equator: *Pistacia terebinthus*, *Campanula rotundifolia*, *&c.*

b. Pores not equatorial: *Passiflora kermesina*, *Impatiens Balsamina* (Pl. 32. fig. 21) (*Noli-me-tangere*).

***** More than four pores.

† Distributed regularly.

a. On the equator: *Alnus glutinosa*, *Ulmus campestris*, *Collomia linearis*, *Campanula Speculum*.

b. All over the grains: *Basella alba* (Pl. 32. fig. 19).

†† Scattered irregularly.

a. Outer coat slightly granular: many Nyctagineæ, Convolvulaceæ, Chenopodiaceæ, Alsineæ, *Alisma Plantago* (Pl. 32. fig. 10), *Plantago lanceolata*, *Ribes nigrum*, *Cactus Opuntia*, *&c.*

b. Outer coat granular and spiny: *Cucurbita Pepo* (with lids, Pl. 32. fig. 22), Malvaceæ (Pl. 32. fig. 26).

c. Outer coat with cell-like reticulations: *Polygonum amphibium*, *persicaria*, *Cobæa scandens*.

Compound porous forms occur in some of the Onagraceæ, and in *Drimys Winteri*, where four grains are conjoined tetrahedrally. In the Mimoseæ groups of eight or sixteen (Pl. 32. fig. 25) occur in various forms. In *Leschenaultia formosa* the grains are quaternate, lying in one plane.

D. Outer coat with both furrows and pores.

* Grains rounded or depressed, with three depressions, each with a pore: most Dipsaceæ and Geraniaceæ (sometimes only two occur, Pl. 32. fig. 22).

** Three furrows and three pores.

a. Outer coat granular; a very common form among Dicotyledons.

b. Outer coat spiny: most Compositæ.

c. Outer coat with cell-like reticulations; rare: *Syringa vulgaris*, *Ligustrum vulgare*, *Grewia occidentalis*, and other species.

*** Outer coat with more than three furrows, each with a pore. Sometimes abnormally, instead of three, but normally in most of the Boraginaceæ and Polygalaceæ.

**** Six to nine furrows, three containing a pore: Lythraceæ, Melastomaceæ, Combretaceæ.

***** Three or four furrows, with six or eight papillæ: *Neurada procumbens*, *&c.*

****** Three furrows and three papillæ not in the furrows: *Carolinea campestris*, *&c.*

Amyloid corpuscles exist in the fovilla of some pollen-grains in the form of very small grains which are stained blue by iodine.

Related compound forms occur in the Ericaceæ and Epacridaceæ, where the grains are tetrahedrally arranged (Pl. 32. fig. 17). Other aberrant forms occur in which the single grains are cubic or dodecahedral; and in the Cichoraceæ polyhedral forms of complicated character are common (Pl. 32. figs. 16, 27, 28).

Mature pollen-grains should be observed dry (as opaque and transparent objects), and in water or glycerine; in some cases, in oil; treatment with acids is also useful in making out structure. In observing the development of pollen, it is necessary to wet the object with a solution of sugar or gum; otherwise the appearances are altogether changed through endosmotic action.

BIBL. Nägeli, *Entwick. des Pollens*, Zurich, 1842, and his papers on Cell-formation translated in *Ray Society's Vols.* for 1846 and 1847; Hofmeister, *Botanische Zeitung*, vi. 1848; Gieswald, *Linnæa*, xxv. p. 81 (1852); Schacht (Coniferæ), *Beitrag z. Botanik*, Berlin, 1854; Saccardo, *Nuovo Giorn. Bot. Nat.* 1872.

POLLEN-TUBE.—Some remarks upon the relation of the ovule to the pollen-tube during impregnation have been made under OVULE. When a perfect pollen-grain comes into contact, either through the agency of insects, wind, or gravity, with a fully matured stigma, or is artificially placed on one, it becomes adherent to the terminal cells of the stigma in consequence of their being more or less covered with a viscid secretion. Either the pollen-grain remains in its first position, or the stigmal cells in the neighbourhood increase in length and more or less envelop and clasp it. Under the influence of heat and the adhesive matter, the internal structures of the grain undergo rapid change, and shortly the internal homogeneous cell-membrane protrudes through one of the openings in the external coat, and, nourished by the viscous secretion, grows rapidly. A fine tube results, which is composed of a homogeneous cell-wall, which contains the fovilla, some of the granules often presenting movements; this delicate tube penetrates between the cells of the stigma by the force incident to growth; and the pollen-grain is prevented from being affected by this force, for it is glued on to the stigma; but if water be applied and the gummy matter be weakened, the grain moves away and the tube appears. The growing tube, nourished by the juices of the female organ, passes into the connective tissue, whose cells are lax and surrounded by granular protoplasm, and thence to the placenta and ovule, or to the ovule at once.

The growth of the tube is very rapid in some and slow in other plants; and its length depends upon that of the stigma, style, and interovarian structures. The tube is cellular in some Monocotyledons; but no cell-wall stretches across in Dicotyledons, and we have found the tubes bifurcating in Violaceæ.

POLYAC'TIS. See BOTRYTIS.

POLYAR'THRA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye single, cervical; foot absent; body with six cirrhi or fins on each side. Jaws each with a single tooth.

1. *P. platyptera* (Pl. 35. fig. 19). Body ovato-subquadrate, fins ensiform serrate. Aquatic; length 1-190″.

2. *P. trigla.* Fins setaceous. Aquatic; length 1-190″.

BIBL. Ehrenberg, *Infus.* p. 440.

POLYCLI'NUM, Sav.—A genus of Tunicate Mollusca, of the family BOTRYLLIDÆ (p. 110).

P. aurantium. Consists of little rounded orange masses, fixed to rocks by a short and thick peduncle.

BIBL. Forbes and Hanley, *Brit. Mollusca*, i. 14.

POLYCOC'CUM, Sant.—A genus of Micro-lichens, parasitic on the prothallus of *Stereocaulon condensatum.*

Char. Spores eight, small, two-locular, brown.

BIBL. Lindsay, *Qu. Mic. Jn.* 1869, p. 343.

POLYCOC'CUS, Kütz.—Probably belongs to *Microcystis.*

POLYCO'PE, G. O. Sars.—A bivalved Entomostracon of the Cladocopa group. Upper and lower antennæ both natatory and setiferous. Two pairs of posterior limbs, the first natatory, the second branchial. No eyes. No heart. Intestine imperforate. Valves circular, thin, smooth, or ornamented. Marine. Recent and fossil.

BIBL. Brady, *Tr. Linn. Soc.* xxvi. 470.

POLYCYS'TINA, Ehr.—A family of Rhizopoda Radiolaria (Müller), or a family of the order Echinocystida, class Rhizopoda (Claparède).

Under every classification these beautiful microscopic objects must be associated with the Acanthometrina and Thalassicollina. Müller distinguishes the Polycystina as an animal enclosed in a siliceous foraminated shell. These shells are very minute and are of many forms. Spherical, conical, egg-shaped, and star-shaped kinds are common; and in most cases there are siliceous prolongations of the body, which are symmetrical and curved, or angular, or branched (Pl. 31. figs. 23–31). The perforations of the shell are large, and cause it to resemble a siliceous reticulation rather than a test. The prolongations of the siliceous skeleton (for such is the shell) are not hollow, but consist of transparent and solid silica, which is developed during the assimilative processes of the animal. The soft parts or sarcode are amœboid in structure and peculiarities; they are contained within the

cavity of the perforate shell; and the prolongations of it surround the siliceous structures, protruding often in a pseudopodial manner. In some instances one siliceous skeleton appears within another, and a kind of division of the sarcode occurs, whilst in other specimens there is an appearance of thick sarcode at the extremities of the produced siliceous processes. The sarcode is olive-brown or yellowish. The Polycystina have been discovered on nearly every ocean floor. Ehrenberg found them at Cuxhaven, and then in the Antarctic seas; Bailey described them from from the depths of the Atlantic; Müller studied them in the Mediterranean, and Häckel in the Adriatic, Wallich in the Indian Ocean; and Wyville Thomson, Carpenter, and Gwyn Jeffreys noticed them in the deep-sea soundings of the North Atlantic. The siliceous skeletons or shells accumulated in thick deposits during the last geological periods, and myriads of these exquisite microscopic forms may be obtained from many strata in Sicily, Greece, Oran in Africa, Bermuda, Richmond, Virginia, and Barbadoes. The Polycystina are best examined as opaque objects, and, if the minute details are required to be seen, as transparent bodies.

Bibl. Ehr. *Monatsber. Berl. Akad.* 1846–1850; *Microgeologie*, 1854; Müller, *Ueber d. Thallass. & d. Polycyst. u. Acanthoe. d. Mittelm. in Abh. d. König. Akad. d. Wiss. zu Berlin*, 1858; Haeckel, *Die Radiolarien*, Berlin, 1862; Furlong, *Qu. Mic. Jn.* i. 1861–64; Claparède et Lachmann, *Etudes*, 434; Wallich, *Trans. Mic. Soc.* n. s. xiii. 75; W. Thomson, *Deep Sea*, p. 98.

POLYCYS'TIS, Kütz. See Clathrocystis. Is a Microcystis.

POLYCYS'TIS, Léveillé.—A genus of Ustilaginei (Coniomycetous Fungi), including several of the old species of *Uredo*; *P. colchici*, *P. parallela* and *P. violæ* are British. See Ustilaginei.

POLYE'DRIUM, Näg. — A genus of Unicellular Algæ, family Protococcaceæ.

Char. Cells single, free, triangular, and the angles more or less produced and elongated.

Bibl. Rabenh. *Fl. Eur. Alg.* iii. 61; Archer, *Qu. Mic. Jn.* 1871, 96.

POLYEM'BRYONY.—This term is applied to a phenomenon occurring sometimes regularly, sometimes abnormally in the development of the ovules of Flowering Plants. In the Angiospermous plants it is usual to find several germinal masses in the unfertilized embryo-sac (see Ovule); but ordinarily only one of these becomes impregnated and developed. Occasionally, however, more than one commences the course of development into an embryo, as in the Orchidaceæ, and more especially in the genus *Citrus*: in most cases all but one become subsequently obliterated; but in the orange this is not the case, and ripe seeds are met with containing more than one embryo. We have met with them in other cases.

Another kind of polyembryony occurs in the Santalaceæ. *Viscum* has two or three embryo-sacs; these may all have their germinal masses fertilized, and the development of the embryos may go on to a certain point until one takes the lead and the others disappear.

In the Gymnospermia (Coniferæ and Cycadaceæ), as described in the article Ovule, there may be one or more (*Taxus*) primary embryo-sacs, in which are produced several *corpuscula*, with secondary embryo-sacs; further, the germinal masses of these, after fertilization, produce suspensors, which branch at their lower ends, and each produces four rudimentary embryos, all but one of them vanishing during the ripening of the seeds. Our space only admits of a brief notice of these interesting phenomena, on which much interesting information will be found in the works referred to below.

Bibl. Meyen, *On Impregnation and Polyembryony* (Berlin, 1840), transl. in *Taylor's Scientific Memoirs*, iii. p. 1; R. Brown, *Ann. Nat. Hist.* xiii. p. 368; Mirbel and Spach, *Ann. des Sc. Nat.* 2 sér. xx. p. 257; Crüger, *Botanische Zeit.* ix. p. 57; Gelesnoff, *Ann. des Sc. Nat.* 3 sér. xiv. p. 189, and the works of Hofmeister cited under Ovule.

POLYGAS'TRICA.—According to Ehrenberg's system, the Infusoria are subdivided into the Polygastrica and the Rotatoria. The so-called Polygastrica correspond to our Infusoria; the Rotatoria form a distinct class.

POLYI'DES, Ag.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one British species, *P. rotundus*, having a branched frond 4 to 6″ high, consisting of repeatedly dichotomous, purplish-brown, solid fibres, about 1-20″ in diameter. The fibres present a central layer of longitudinally arranged filamentous cells, and a cortical layer of perpendicular, dichotomous filaments, formed of elliptical cells internally, terminating at the surface in minute moniliform rows. The fructification con-

sists of:—1. *favellæ* bearing spores, contained in superficial wart-like bodies, composed of colourless articulate filaments; 2. tetrahedrally divided *tetraspores*, embedded in the peripheral filaments of the cortical layer of the frond. Antheridia have not yet been observed.

BIBL. Harvey, *Brit. Mar. Alg.* p. 146, pl. 18 D; *Phyc. Brit.* pl. 95; Greville, *Alg. Brit.* pl. 11.

POLYMORPHI'NA, D'Orb.—A genus of hyaline Foraminifera. Inequilateral, oblong or elongate, globose or compressed (Pl. 18. fig. 40, *P. communis*; fig. 42, *P. oblonga*; fig. 43, *P. compressa*); chambers often numerous, alternate in two rows, slightly embracing, but always more so on one side than the other; orifice round, at the summit of the last chamber, radiate. Sometimes the later chambers have branching, tubular apertures (*P. Orbignii*, Pl. 18. fig. 41).

Many species in all seas; fossil from the Trias upwards.

BIBL. Williamson, *Rec. For.* 70; Carpenter, *Introd. For.* 166; Brady, Parker, and Jones, *Tr. Linn. Soc.* xxvii. 197.

POLYNE'MA.—A genus of Hymenoptera. The perfect insect is aquatic in its habits, swimming by means of its wings. It lays its eggs inside those of Dragonflies; and the embryo has the form of a bottle-shaped mass of embryonal cells covered with a thin cuticle. Protected by the shell of the egg and bathed by the juices therein, the larva is nourished and developed.

BIBL. Lubbock, *Linn. Trans.* 1863; *Metam. Insect.* 37.

POLYOM'MATUS, Latr.—A genus of Lepidopterous Insects, of the family Lycænidæ.

Char. Antennæ terminated by a contracted knob; tarsal claws minute; wings not tailed.

The (thirteen) species are small butterflies, the upper surface of the wings of a beautiful blue colour, the under side grey or brownish, and with numerous eye-like spots.

The scales upon the under surface of the wings of *P. argiolus* and *P. argus* have been proposed as test-objects. They are of two kinds—one resembling in structure the ordinary scales of insects, the other of a battledore form (Pl. 27. figs. 20 & 21). See SCALES of Insects and TEST-OBJECTS.

The species are figured in Westwood's *British Butterflies.*

POLYPHE'MUS, Müll.—A genus of Entomostraca, of the order Cladocera, and family Polyphemidæ.

Char. Head distinct from the body; abdomen long, slender, and projecting externally from the shell.

P. pediculus (Pl. 14. fig. 29). The only species. Aquatic.

BIBL. Baird, *Brit. Entomostr.* p. 111.

POLYPHRAG'MA, Reuss.—A large stichostegian *Lituola*, with numerous short chambers and cribrate septa. Fossil; Cretaceous. Saxony and Bohemia.

BIBL. Von Reuss, *Geinitz's Elbthalgebirge*, I. iv. 139.

POLYPI.—A class of the invertebrate subkingdom Radiata, which has been very generally discarded, or else limited on account of its including or separating organisms presenting very marked structural distinctions. At present, those naturalists who retain the class group together the Actiniaria or Malacodermic Zoantharia and the Antipatharia or Sclerobasic Zoantharia in one subclass. The second subclass is that of the Alcyonida, and the third that of the Madreporaria or Sclerodermic Zoantharia—the Stony Corals. Thus Milne-Edwards and Jules Haime group the above as the "Polypes properly so called;" and A. Agassiz, recognizing the class, divides it into the Actinoids, Halcyonoids, and Madreporians. Other authors extend the class, and cause it to embrace the Hydrozoa and Polyzoa besides the above-mentioned groups. It is impossible to form a philosophical classification which can separate absolutely the Hydrozoa from the Actinoids, Halcyonoids, and Madreporaria; and therefore these being grouped as Actinozoa are classed with the Hydrozoa in the subkingdom Cœlenterata of Frey and Leuckart. The Polyzoa have no affinity as a class with the Actinozoa or Hydrozoa, and are therefore eliminated. The Cœlenterata have the mouth opening into a digestive cavity without an anal termination; and in the Actinozoa the reproductive organs are within this cavity or open into it, so that the ova and young are voided by the mouth; the Hydrozoa, on the contrary, have the reproductive organs external to the digestive cloaca. For the articles referring to the Cœlenterata, see ACTINIA, ALCYONIUM, and ZOANTHARIA, the anatomy being given under the last head. See Pl. of Polypes.

POLYPODIA'CEÆ.—An order of Ferns, divided into six families by the characters of the sporanges.

Synopsis of the Families.

1. Polypodioideæ. Sporanges numerous, united in sessile sori, and divided into two equal parts by a vertical annulus.

2. Cyatheææ. Sporanges numerous, united in sori on a salient axis; with a somewhat oblique annulus.

3. Gleicheniеæ. Sporanges united in fours into sori, and surrounded by an oblique annulus, like a turban.

4. Parkerieæ. Sporanges not united in sori, and divided into two equal parts by a more or less extensive vertical annulus.

5. Osmundeæ. Sporanges united in sori, and covered on the back by a broad and imperfect annulus.

6. Schizææeæ. Sporanges united in sori, and crowned by an annulus that looks like a skull-cap with radiating streaks.

POLYPODIE'Æ.—A tribe of Polypodioid Ferns:

Illustrative Genera.

* *Veins pinnate.*

† *Margins of the fertile fronds not revolute.*

1. *Polypodium*, L. Sori globose, seated on the apex or the back of veins or venules.

2. *Marginaria.* Sori globose, immersed deeply in the backs of veins or venules.

3. *Pleopeltis.* Sori globose, seated on the backs of veins and venules, with peltate paraphyses concealing the sporanges.

†† *Margins of the fertile fronds revolute.*

4. *Struthiopteris.* Sori globose, seated on the backs of veins and venules.

** *Veins anastomosing, without free veins in the areolæ.*

5. *Dictyopteris.* Sori globose, seated on the anastomosing venules. Venules anastomosing in irregular hexagonal spots.

*** *Veins anastomosing, with free veins in the areolæ.*

6. *Niphobolus.* Sori globose, seated on the apex of the venules. Venules very much branched, forming transverse rhomboid spots; secondary venules arising from the transverse venules, and bearing the sori at their apices.

POLYPODIOIDE'Æ.—A family of Polypodiaceous Ferns, of large extent, broken up into tribes and genera, which are characterized by peculiarities generally requiring a more or less powerful lens to distinguish them. In certain cases, where the venation of the leaves, and the relation of this to the fructifying points, are in question, it is found very convenient to scrape off the sori of pinnules and place them in spirits of turpentine or oil, between two slips of glass, for examination with a low power under the microscope by transmitted light. The general arrangement of the sori, with the *indusium*, in very minute forms, is best observed as an opaque object, with a low power, and a lieberkuhn or side condenser; if held in the mounted forceps, the pinnule can be turned about and thoroughly examined.

Synopsis of the Family.

A. *Without an indusium.*

1. Acrosticheæ. Sporangia scattered over the whole surface.

2. Tænitideæ. Sori linear, extending to the areolæ of the leaves.

3. Grammitideæ. Sori linear, confined to the veins or veinlets.

4. Polypodieæ. Sori at the apices of veins.

5. Vittarieæ. Sori in the grooved margin, which simulates an indusium.

B. *With an indusium.*

6. Adianteæ. Sori linear, marginal, at the apices of veins, indusium spurious, formed by the revolute margin.

7. Dicksonieæ. Sori globose, apical, indusium lateral, two-valved.

8. Davallieæ. Sori apical, inframarginal, indusium one-valved.

9. Asplenieæ. Sori on the veins, indusium persistent, lateral, the margin free.

10. Aspidieæ. Sori subglobose, indusium with a central or excentric point of attachment, free all round.

11. Peranemeæ. Indusium inferior, ultimately lobed or ciliated.

Bibl. See Ferns.

POLYPO'DIUM, Linn.—A genus of Ferns with naked sori, of which there are several indigenous representatives, *P. vulgare*, the Oak-Fern, being one of our commonest species. Exceedingly well adapted for examination of the structure of the sori and sporanges in this family.

POLYPORE'I.—A family of Hymenomycetous Fungi, characterized by bearing basidiospores clothing tubes, pores, or pits, on the under side of a stalked or sessile *pileus*, or fleshy cap or disk. The basidiospores are seen by horizontal sections from

the under-surface of the pileus. (See BASIDIOSPORES and HYMENOMYCETES.)

BIBL. Berk. *On Fruct. of Fungi, Ann. Nat. Hist.* i. 81; Léveillé, *Ann. des Sc. Nat.* 2 sér. viii. 324.

POLYP'ORUS.—A genus of Polyporei abounding in species, many of which are widely distributed. Above eighty species are found in this country; and the exotic species are multitudinous. From *P. fomentarius* amadou is prepared, which is not only used for tinder, but for articles of clothing. *P. officinalis* used to form an article of materia medica; and several species are esculent. The pietra fungaja (an earthy mass traversed by mycelium), when properly treated, gives rise to an esculent species, which has been brought to perfection in our stores.

POLYSAC'CUM, D. Cd.—A genus of Trichogastres (Gasteromycetous Fungi), having a common peridium filled with peridiola; the spores mixed with threads. One species only occurs, and very rarely in this country. Abroad they grow on exposed sand. One of the species has been used in dyeing.

BIBL. Fr. *Syst. Myc.* iii. p. 54; Berk. *Outl.* p. 304; Sow. t. 425; Cooke, *Handb.* p. 375.

POLYSEL'MIS, Duj.—A doubtful genus of Infusoria, of the family Euglenia.

Char. Oblong or variable in form, with several anterior flagelliform filaments, and a single red eye-spot.

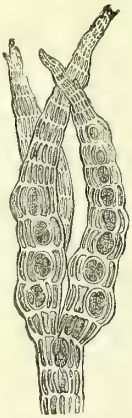
Probably the zoospore of a Confervoid Alga.

P. viridis (Pl. 24. fig. 68) resembles a *Euglena* of an oblong form with the ends rounded; one of the filaments is longer than the three or four others which surround its base. Aquatic; length 1-650″.

BIBL. Dujardin, *Infus.* p. 370.

POLYSIPHO'NIA, Grev.—An extensive genus of Rhodomeleæ (Florideous Algæ) or Red sea-weeds, with cylindrical, more or less articulated fronds, the joints consisting of a circle of longitudinally arranged cells surrounding a central cell (like the wood-bundles of a young Dicotyledonous stem surrounding the pith), so that the transverse section presents the appearance of a rosette; the number of peripheral cells varies among the 300 different species of this genus, from four to twenty-five. The British forms mostly have four and six. In some of the species a kind of rind is formed subsequently, by a growth from the base of the joints analogous to that which occurs in BATRACHOSPERMUM and CALLITHAMNION. The fructification consists of:—1. *ceramidia*, urn-shaped or ovate, attached to the sides of branches, containing numerous pear-shaped spores at the base; 2. *tetraspores* on distinct plants, formed in the swollen central cell of distorted branches (fig. 598); these are gonidia and develop a thallus; and 3. *antheridia*, elongated whitish sacs, collected in great numbers at the summits of the branches, accompanied by a dichotomous hair, and sometimes prolonged into a hair-like process at the summit. Nägeli describes the spermatozoids as consisting of a spiral filament. Thuret disagrees with this, and states that they are merely hyaline globules, about 1-5000″ in diameter without active motion. The British species are placed in two subgenera—*Oligosiphonia*, where there are but four or rarely five peripheral cells, and *Polysiphonia*, where there are six or more. Twenty-six species are described, many of which are common.

Fig. 598.



Polysiphonia nigrescens.

Distorted ramuli containing imbedded tetraspores.

Magn 50 diams.

BIBL. Harvey, *Brit. Mar. Alg.* p. 82, pl. 12 A; Thuret, *Ann. des Sc. Nat.* 3 sér. xvi. p. 16, pl. 6; Nägeli, *Zeitsch. f. wiss. Botan.* Heft 3 and 4 (1846). p. 207, pls. 6 & 7; Henfrey, *Elem. Course* (Masters), p. 433.

POLYSTOMEL'LA, Lamk.—A genus of hyaline Foraminifera. Shell free, regular, equilateral, biconvex, sometimes compressed, often dorsally keeled; *spire* embracing; *chambers* with a single cavity, straight or arched, meeting at the umbilicus and furnished with transverse pits between the sutures or over them. *Orifices* numerous, arranged along the margin of, or forming a triangle at, the upper part of the last chamber. *Polystomella* passes into *Nonionina*, through *P. striato-punctata* (Pl. 47. f. 19), common in cold seas.

P. crispa (Pl. 47. fig. 20) is common in temperate seas. *P. craticulata* is of tropical growth. *P. macella* (*Faujasina*) is unsymmetrical and starved. Many fossil forms.

BIBL. D'Orbigny, *For. Foss. Vien.* 121; Williamson, *Recent Foram.* 39; Morris, *Brit.*

Fossils, 40; Parker & Jones, *Ann. N. H.* ser. 3, v. 103; Carpenter, *Introd. For.* 276.

POLYTHALA'MIA. See FORAMINIFERA.

POLYT'OMA, Ehr.—A genus of Infusoria, of the family Monadina (Hydromorina).

P. uvella (Pl. 24. fig. 69, undergoing division), the only species, is oblong or oval, obtuse at the ends, colourless, furnished with two flagelliform filaments; it has no carapace. Aquatic; length 1-2200 to 1-960″; size of body when the division is nearly complete, 1-400″.

As it increases in size it assumes a wrinkled or mulberry appearance; and this appearance indicates the approaching division into many sections, whence the name.

BIBL. Ehr. *Infus.* p. 24; Schneider, *Ann. Nat. Hist.* 1854, xiv. p. 321; Pritchard, *Infus.* p. 136 & 504.

POLYTRE'MA, Blainville.—A protean parasitic Foraminifer of the Rotaline family; scale-like, globular, or arborescent, with labyrinthic structure. *P. mineaceum* is widely distributed in the Mediterranean and other warm seas.

BIBL. Carpenter, *Introd. For.* 235; Schultze, *Wiegm. Arch.* 1863, 81; *Ann. N. H.* 3. xii. 409.

POLYTRICHA'CEÆ. — A tribe of Mnioideæ (operculate Mosses of usually Acrocarpous habit).

Genera.

1. *Catharinea.* Calyptra narrowly hood-shaped, subscabrous at the apex, rather hairy within. Peristome simple, composed of thirty-two teeth, arising from a narrow, cellular basilar membrane, ligulate, membranous, white, with many percurrent, reddish, inarticulate filaments, somewhat incurved, scarcely hygroscopic, firm. Columella dilated at the apex into a drum-like epiphragm. Capsule equal. Inflorescence monœcious or diœcious.

2. *Polytrichum.* Calyptra dimidiate, but appearing campanulate on account of a quantity of very close hairs descending from it as a long villous coat; otherwise resembling the preceding genus.

POLYT'RICHUM, Dill. — A genus of Polytrichaceous Mosses, variously defined by different authors. In the British Flora, it includes the forms separated in this work under CATHARINEA, which in the 'Bryologia Britannica' are divided between *Atrichum* and *Oligotrichum*. The species of *Polytrichum* comprised in our definition are distributed in the same work under *Pogonatum* (those with a round capsule and thirty-two teeth) and *Polytrichum* proper (those with a square or prismatic apophysate capsule (fig. 600), and usually twice as many teeth). *P. commune* is one of our finest Mosses, common on heaths, moors, and mountain tracks, varying somewhat under the different physical conditions. The stems are from 6″ to 1′ long, and the fruit-stalks 2 or 3″. The stems are almost of woody texture, the leaves large and firm. The calyptra is densely covered with hairs. Wilson remarks that the true structure of the sporange and columella of Mosses may be most easily learned from the study of this genus. The columella is seen (figs. 601, 603) to be separated from the spores by an inner layer of the sporangial membrane. The diaphragm attached to the apices of the teeth of the peristome is the dilated apex of the columella (fig. 603).

Fig. 599.

Polytrichum commune.

Plants in fruit.

One half natural size.

Fig. 600.

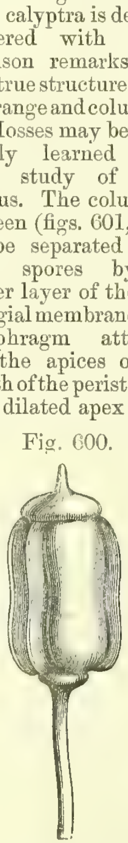
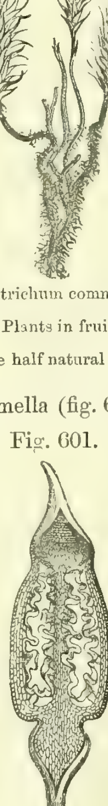


Fig. 601.



Polytrichum commune.

Capsule with operculum. Magnified 10 diameters.

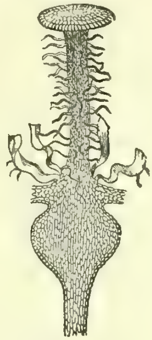
Section of young capsule showing the plaited sporangial membrane.

The peristome (fig. 602) is composed of

ligulate obtuse teeth, connected by a membrane at the base, continuous with the inner layer of the wall of the capsule. These

Fig. 602.

Fig. 603.



Polytrichum commune.

Fragment of peristome. Magn. 100 diams.

Columella with section of the apophysis. Magn. 25 diams.

plants are also exceedingly well adapted for the examination of the male inflorescence and spermatozoids. They are all diœcious; and the male plants (fig. 604) are readily

Fig. 604.

Fig. 605.

Polytrichum commune.

Male inflorescence. One half nat. size.

Innovation from male inflorescence. Magn. 5 diams.

distinguishable by the cup-shaped inflorescence, composed of scale-like leaves and paraphyses surrounding a number of subulate sacs constituting the *antheridia*. The male flowers of *P. commune, juniperinum*, &c. are found everywhere on heaths in spring. The antheridia may be readily extracted under a simple lens, and, when placed in water under the compound microscope, soon (if ripe) burst at the summit and discharge the spermatozoids; these usually escape still enclosed in their parent cells, which when first discharged cohere in a gelatinous mass; but the ciliated spermatozoids (Pl. 32. fig. 33) escape and swim actively in the water. They require at least an eighth object-glass for examination; and the cilia are seen most clearly after drying the object, or treating it with tincture of iodine.

Bibl. Wilson, *Bryol. Britann.* p. 205 *et seq.*; Thuret, *Ann. des Sc. Nat.* 3 sér. xvi. p. 26, pl. 14.

POLYZO'A or BRYOZOA.—A class of Animals, belonging to the subkingdom Molluscoida.

Char. Polypiform, aggregate; individual bodies microscopic, contained in horny or calcareous cells, often connected by tubular stems, forming a usually branched polypidom; mouth surrounded by long, ciliated, uncontractile tentacles; flexure of alimentary canal neural, mouth and anus separate, but near each other. Marine and aquatic.

They are found everywhere on the seashore, either rooted to, or forming a crust upon submerged rocks, stones, shells, &c. The individual is called a polypide; and the aggregate or colony constitutes a cœnœcium or polyzoarium; it is usually of a whitish or brownish colour, of a horny or calcareous texture, and consists either of cells or cups simply aggregated (Pl. 33. figs. 17, 20), or connected by tubular stems, and often arranged in elegant plant-like forms (Pl. 33. fig. 5 *a*). Although there is no direct tubular communication between the cells of a polyzoarium, still there is an evident bond of connexion between them, which is probably in the continuity of the external integument. There may be also a slow interchange of cell-matters between contiguous and long lines of cells.

The cells formed by the ectocyst are lined with a delicate membrane (*endocyst*), which terminates at the base of the tentacles, to be reflected upon the alimentary canal; this is soft, membranous, and contractile, and possesses a minutely cellular structure. The polypide cells are of various forms, mentioned under the genera, and they are often furnished with bristles or spines. At

or near the distal end of each cell is the orifice, through which the tentacles and more or less of the body of the animals are protruded. In the marine or Infundibulate order, the structure of the cell-mouth is used as a character,—those in which it is terminal and simple (Pl. 33. fig. 30) forming the Cyclostomata, and those in which it is subterminal, curved, and furnished with a movable lid the Cheilostomata (Pl. 33. fig. 5 *b*); whilst in the Ctenostomata there is a comb-like circular fringe of bristles connected by a membrane surrounding the cell-orifice, visible when the body is partly protruded. Most are fixed; but *Cristatella* is free and locomotive, having a discoid base.

Curious appendages are found attached mostly to the cells of the polypidoms. The first are called bird's-head processes or *avicularia* (Pl. 33. figs. 5 *b**, and fig. 26). They consist of a body (fig. 26 *f*), a hinge- or lower-jaw-like process (fig. 26 *e*), and a stalk (*f*). They are attached by the stalk to the interior of a round hollow process, projecting slightly from the surface of the polypidom (fig. 26 *a*). The body is divided by an oblique ridge (fig. 26 *d*) on its inner surface into two chambers. The lower portion is moved up and down by an elevator and depressor muscle (fig. 26 *c*). During life the motion is constant; and it continues long after the death of the animal. These bodies appear analogous to the pedicellaria of the Echinodermata.

The second kind, called *vibracula*, consist of a hollow process (fig. 5 *d, b*), from which a vibrating filament (fig. 5 *d, d*) projects. The interior of the process is filled with a contractile substance which moves the filament.

The body is usually oblong or elongate. At its anterior end is a ring or disk (*lophophore*), upon which the tentacles are placed; this is perfect in the Infundibulata, but deficient at one part, or horse shoe-shaped in the Hippocrepia (Pl. 33. figs. 3 *c* & 9). The tentacles are hollow, closed at the end, uncontractile, coated externally with cilia on the sides next each other, and communicate with the cavity of the body, through apertures in the disk. In most of the Hippocrepia, the tentacles are surrounded at the base by a transparent cup-like membrane (*calyx*), prolonged somewhat upon each tentacle, and mostly dentate at the margin.

Digestive System.—The mouth is situated in the middle of the tentacular disk (Pl. 33. fig. 3 *c*), and is closable in the Hippocrepia by an epiglottis-like hollow valve (*epistome*), which is absent in the Infundibulata; at the base of this valve is an aperture which perforates the disk to open into the abdominal cavity. The mouth terminates in a pharynx (Pl. 33. fig. 5 *e, f*) and œsophagus (fig. 18*, *b, d*) often of considerable length, which is sometimes succeeded by a strongly muscular gizzard. Next comes the stomach (figs. 5 *e*, *b**, 18*, *f*), often very capacious, and with an appendix (fig. 18* *e*), and finally the intestine (fig. 18* *g*), which terminates outside, but close to the disk (fig. 5 *e, c*). Thus the alimentary canal is bent upon itself, the two orifices being very near each other.

The alimentary canal consists of three coats—an inner rugose, composed of cells with brownish contents, and representing a liver; a middle, composed of colourless nucleated cells; and an outer, thin, cellular coat, probably containing muscular fibres. The mouth and more or less of the upper portion of the alimentary canal are ciliated.

The walls of the cavity of the abdomen, the interior of the disk and of the tentacles all communicate, and are filled with a clear liquid, in which irregular particles float, and in which a constant rotatory motion exists, produced partly by muscular action, and partly by cilia. This liquid corresponds to a chylaqueous fluid, and performs the chyliferous, sanguiferous, and respiratory functions; for there are no distinct respiratory organs nor blood-vessels.

The muscular system is well-developed, the fibres being transversely striated—the principal, or retractors, arising from the bottom of the cells, and being inserted into the sides of the œsophagus, so as to exert a retracting action upon the body. There are also parietal muscles, which are in the form of circular bundles running transversely round the cell; they project the polypide.

The nervous system consists of an oval ganglion placed between the oral and anal apertures, and giving off branches to the tentacles, alimentary canals, &c.; and there is a nervous connexion between all the cells of a polyzoarium, called the colonial system.

Reproduction.—The Polyzoa are propagated by gemmation, and by the agency of sexual organs.

Two kinds of gemmation occur. In the first, the gemmæ are developed externally from the parent cells, and usually near the orifice, but often from the stem; these gemmæ, on attaining their full development

remain attached to the parent, thus forming the compound organism. In the second, they are formed internally, as buds upon the funiculus, which is a process passing from the testis to the stomach. Afterwards they become free within the abdominal cavity, from which they escape at an orifice near the disk, according to Van Beneden, although this is denied by Allman. The latter kind, which are often called ova, have an external hard coat, exhibiting the appearance of a marginal ring, and are often of a dark colour. Their development is not dependent upon impregnation; and they seem to correspond to the winter ova of the Entomostraca &c.: Allman proposes the name *statoblasts* for them. The sexual organs, which usually exist together in the same individual cell, consist of a roundish ovary, attached by a short peduncle near the orifice of the cells; whilst the testis is a roundish irregular mass attached to the funiculus. The ova, which are first set free in the abdominal cavity, are ciliated and swim freely.

Smith distinguishes four modes of reproduction in the Polyzoa, three of them taking place in an asexual way:—1. The growth of the whole colony by buds which are external; 2. The reproduction by eggs formed by internal buds of the endocyst; 3. The production of new polypides and eggs in empty cells (zoœcia), by brown bodies which are produced out of the former polypide of the cell by retrogressive metamorphosis or degeneration; 4. Sexual reproduction by eggs and spermatozoa.

Table of the Divisions of the Polyzoa.

Order I. PHYLACTOLÆMATA.

Lophophore bilateral; mouth with an epistome.

Suborder 1. *Lophopea* (freshwater).

Arms of lophophore free or obsolete; consistence horny, subcalcareous.

Suborder 2. *Pedicellinea* (marine).

Arms of lophophore united at their extremities; consistence soft, fleshy.

Suborder 3. *Rhabdopleurea* (marine).

Cœnœcium branched, adherent, membranous, with a solid chitinous rod on its adherent side, to which the polypides are attached by their funiculi. Lophophore completely hippocrepian, with a peculiar shield-like body on its hæmal side. No epistome (?).

Order II. GYMNOLÆMATA.

Lophophore orbicular, or nearly so; no epistome.

Suborder 4. *Paludicellea* (fresh water).

Polypide completely retractile; evagination of tentacular sheath imperfect; consistence horny or subcalcareous.

Suborder 5. *Cheilostomata* (marine).

Polypide completely retractile; evagination perfect; orifice of cell subterminal, of less diameter than the cell, and usually closed with a movable lip or shutter, sometimes by a contractile sphincter; cells not tubular; consistence calcareous, horny, or fleshy.

Suborder 6. *Cyclostomata* (marine).

Cell tubular; orifice terminal, of the same diameter as the cell, without any movable apparatus for its closure; consistence calcareous.

Suborder 7. *Ctenostomata* (marine).

Orifice of the cell terminal, furnished with a usually setose fringe for its closure; cells distinct, arising from a common tube; consistence horny or carnose.

BIBL. Johnston, *Brit. Zooph.* 253; Busk, *Catal. of Marine Polyzoa* (*Brit. Mus.*); Fossil, in *Pal. Soc.* 1859; Siebold, *Vergleich. Anat.* 25; Farre, *Phil. Trans.* 1837; Dumortier and Van Beneden, *Mém. de l'Acad. de Brux.* 1850; Vogt, *Zool. Briefe*, i. 246; Hancock, *Ann. Nat. Hist.* 1850, v.; Leuckart, *Van d. Hoeven's Zoologie* (*Nachträge*), 47; Allman, *Freshwater Polyzoa, Roy. Soc.*; Gosse, *Mar. Zool.* ii. 1; Fr. Müller, *Wieg. Archiv*, 1860, 311; Huxley, *Qu. Mic. Jn.* iv. 191; Busk, *Trans. Mic. Soc.* 1854, 26; Smitt, see *Qu. Mic. Jn.* 1871, 155; Van Beneden, *Rech. &c., Mém. Acad. Roy. de Brux.* t. xviii.; Fritz Müller, *Reich. u. Dubois Reymond's Archiv*, 1860; Claparède, *Mo. Mic. Jn.* 1871, p. 98; *Sieb. & Köll. Zeit.* 1871, p. 137; Norman, *Qu. Mic. Jn.* 1868, p. 212; Hyatt, *On Polyzoa*; *Proc. Essex Institute, U.S.A.* 1868; Nitsche, *Sieb. & Köll. Zeit.* 1870; Hincks, *Qu. Mic. Jn.* 1873, p. 16.

POM'PHOLYX, Gosse.—A genus of Rotatoria, of the family Brachionæa.

BIBL. Gosse, *Ann. Nat. Hist.* 1851. viii. p. 203.

POMPHOLYX'OPHRYS, Archer (Syn. *Hyalolampe*, Greef).—A genus of freshwater Rhizopoda.

Char. Rhizopod composed of two distinct sarcode regions, the inner a dense coloured

globular sarcode mass, the other colourless, and bearing a number of separate hyaline globular structures; these are disposed in a layer around the inner globe, which latter gives off slender non-coalescing pseudopodia.

Bibl. Archer, *Qu. Mic. Jn.* 1870, p. 105.

PON'TIA, Fabr.—A genus of Lepidopterous Insects, of the family Papilionidæ.

This genus contains some of the commonest butterflies, as *P. brassicæ*, the large cabbage-butterfly; *P. rapæ*, the small cabbage-butterfly; and *P. napi*, the green-veined white butterfly.

The form and structure of certain scales existing upon the under side of the wings of the males are curious; and the markings were formerly found so difficult to render distinct, that the scales were used as test-objects.

In the male *P. brassicæ* the upper surface of the anterior wings is free from spots, whilst in the female there are two black spots in that situation. The peculiar scales are represented in Pl. 27. fig. 24; fig. 26 exhibits a portion of the wing with the ordinary scales.

In *P. rapæ and P. napi* the anterior wings of the males have a single spot upon the upper surface, whilst there are two upon each wing in the females. The peculiar scales bear considerable resemblance in the two species (Pl. 27. fig. 23 *a*, scale of *P. rapæ*; fig. 23 *b*, portion of wing, showing the points of attachment of the two kinds of scales).

The scales may be separated by gently pressing the under surface of the wings against a slide.

See Scales of insects and Test-objects.

Bibl. Westwood, *Brit. Butterflies.*

PONTOCY'PRIS, G. O. Sars.—An Ostracode, near *Argillœcia* among the *Cypridæ*, with fragile pod-like valves, higher in front than behind; no branchial appendage on the second pair of jaws; upper antennæ long and setiferous. 3 British species, rather common.

Bibl. G. S. Brady, *Tr. Linn. Soc.* xxvi. 384.

POPPY.—The seeds of Poppies (*Papaver*, L., Nat. Order Papaveraceæ) are elegant opaque objects under a low power, the testa being pitted so as to produce a reticulated surface (Pl. 31. fig. 14).

PORIF'ERA. See Spongida.

POROCYC'LIA, Ehr.—A genus of Diatomaceæ closely allied to Liparogyra.

Bibl. Pritchard, *Infus.* 823.

PORODIS'CUS, Grev.—A genus of Diatomaceæ, fam. Melosiræ, of the group Pixidicula.

Bibl. Rabenht. *Fl. Eur. Alg.* i. 34; Greville, *Mic. Trans.* 1863, p. 63; 1865, p. 46.

PORO'NIA, Fr.—A genus of Sphæriacei (Ascomycetous Fungi), consisting of a corky stroma, which is flat or hollowed out at the top, and studded with the ostiola of the perithecia. The only British species is not uncommon on horse-dung.

Bibl. Fr. *Syst. Myc.* ii. p. 330; Berk. *Outl.* p. 385; Cooke, *Handb.* p. 791; Tul. *Carp.* ii. p. 27, t. iii.

POROUS STRUCTURES of Plants.—What are ordinarily called porous tissues in vegetable anatomy are described in accordance with their real nature under the head of Pitted structures. True pores do, however, occur in the walls of vegetable cells, from secondary or ultimate changes in their character. They are seen in the cells of the leaves of *Leucobryum* and *Sphagnum* (see Sphagnaceæ). Other regular orifices are produced in the walls of the cells of many of the zoospore-producing Confervæ, as *Conferva, Cladophora, Enteromorpha*, &c. (see Pl. 5). The wall of the sporangial cell of *Achlya* presents analogous openings; and according to Cohn, pores are produced in the spore-cells of Sphæroplea to admit the spermatozoids. The pits and the interstices between reticulated fibrous secondary deposits are often changed into true holes in old cells; but this is a result of decay of the primary membrane; it takes place very early, however, at the contiguous ends of Spiral-fibrous and Pitted cells coalescing to form ducts, changing the septum formed by the adjoining ends into a kind of grating, or irregularly torn diaphragm.

Bibl. See the heads referred to in this article.

PORPE'IA, Bail.—A genus of Diatomaceæ, closely allied to Biddulphia. Gulf-stream.

Bibl. Pritchard, *Infus.* 350; Rabenht. *Fl. Eur. Alg.* i. 315.

POR'PHYRA, Ag.—A genus of Porphyraceæ (Rhodophycaceous Algæ), with an expanded, membranous, shortly-stalked frond, composed of a single layer of cells approximated in fours, the contents of purple or red colour. Fructification consisting of:—1. scattered sori of oval *spores*; 2. *octospores* immersed in the frond; and 3. *antheridia*, on the same or distinct plants. *P. laciniata* and *vulgaris* are common on our coasts.

Bibl. Harvey, *Brit. Mar. Alg.* p. 261, pl. 25 A; Thuret, *Mém. de la Soc. Nat. de Cherbourg*, ii. 1854; *Ann. des Sc. Nat.* 4 sér. iii. p. 5; Janezewski, *Mém. de la Soc. Nat. de Cherbourg*, xvii. p. 345.

PORPHYRA'CEÆ.—A tribe of Florideous Algæ (according to Thuret), of low organization, forming Ulvoid membranous fronds or strata of Confervoid filaments, of a purple or red colour. They are placed among the Ulvaceæ by most authors, but differ in the absence of the zoospores and the presence of tetraspores (octospores) and antheridia. They are marine,—*Porphyra* growing on rocks and stones, *Bangia* the same, or parasitic upon *Zostera*, Algæ, &c.

British Genera.

1. *Porphyra.* Frond plane, membranous, very thin, of a purple colour, with oval spores in sori, and tetraspores (squares) scattered all over the frond.

2. *Bangia.* Frond filiform, tubular, composed of numerous radiating cells in transverse rows, enclosed within a continuous hyaline sheath.

PORPHYRID'IUM, Näg. = *Palmella cruenta* ?

PORRI'GO. See Favus.

POTAMOCY'PRIS, Brady.—One of the *Cypridæ*; valves reniform, thick, right larger than left; upper antennæ with very short setæ; postabdominal rami rudimentary. 1 British species.

Bibl. G. S. Brady, *Nat. Hist. Tr. North. & Durham*, iii. 365.

POTASH, and its salts.

Caustic Potash.—The strength of the solution may be that of the Liq. Potassæ of the Pharmacopœia. But we prefer a stronger solution made with 1 drachm of the *potassa fusa* or stick-potash of the shops, and 1 fluid oz. of water. The solution should be allowed to settle, and the clear portion poured off into one of the test-bottles (Intr. p. xxiv).

Some remarks are made upon the action of potash in the Intr. p. xxxix, and others under the heads of the tissues, &c. On treating organic substances with this reagent, the cystic-oxide-like crystals of the carbonate (Pl. 6. fig. 7*) will frequently be formed.

Chromates of Potash.—The bichromate is used in the preparation of the chromate of lead for injection. Its crystals polarize well. The neutral chromate is also sometimes used for preparing injections. See Preparation.

Nitrate of potash, nitre, or saltpetre.—This salt is dimorphous: it usually crystallizes in six-sided prisms with dihedral summits, or in other forms belonging to the right-rhombic prismatic system. But sometimes it assumes the form of obtuse rhombohedra, resembling those of nitrate of soda, and referable to the rhombohedric system.

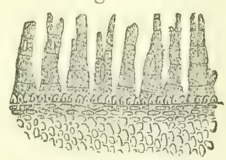
The crystals exhibit very beautifully the phenomena of Analytic Crystals.

The arseniate, bichromate, bicarbonate, bitartrate, carbonate, chlorate, hypermanganate, nitrate, oxalate, red and yellow prussiate, and sulphate of potash, besides the iodide, are very interesting objects both as simple crystals and for polarization. The oxalate of chromium and potassium is dichroic.

Bibl. That of Chemistry.

POT'TIA, Ehr.—A genus of Pottiaceous Mosses, including some of the *Gymnostoma* and *Weissiæ* of Hedwig and others. Wilson separates as *Anacalyptæ* the species with a peristome (fig. 606).

Fig. 606.



Pottia cæspitosa.
Fragment of peristome.
Magnified 50 diameters.

POTTIA'CEÆ. — A tribe of Pottioid Mosses.

Synopsis of Genera.

1. *Pottia.* Calyptra dimidiate. Peristome simple or wanting; if present, composed of lanceolate articulate teeth, simple or with a longitudinal line, rugulose and somewhat fleshy.

2. *Trichostomum.* Calyptra dimidiate. Peristome simple, sixteen teeth split to the base into two cilia, or irregularly and therefore into more than two, erect, stiff, and not twisted.

3. *Barbula.* Calyptra dimidiate-hood-shaped. Peristome simple, ciliiform; cilia thirty-two, solitary or approximated in pairs on a more or less exserted basilar membrane, split into two cilioles behind, very long, articulate-rugulose, twisted to the left, rarely to the right, in one or several spires,

hygroscopic. Cells of the operculum and calyptra twisted in the same way.

4. *Ceratodon.* Calyptra dimidiate. Peristome simple; teeth sixteen, connate at the base into a cellular membrane, split into two long, nodosely articulated, dark-coloured arms, paler on each side, densely trabeculated at the lower part. Capsule thick-skinned, shining, nodding, with a somewhat nodose collum; annulate.

5. *Weissia.* Calyptra dimidiate. Peristome simple or wanting; if present, composed of sixteen lanceolate or subulate, entire or cribrose, equidistant teeth.

POTTIOI'DEÆ.—A family of operculate Mosses belonging to the Acrocarpi, but sometimes Pleurocarpous by innovating branches. Leaves of very varied form, with a terete nerve; cells parenchymatous, perfectly hexagonal or squarish six-sided, always looser at the base, sometimes very lax, more or less pellucid, often exceedingly transparent, large, fragile, rigid, foraminate, bearing on the upper side solitary papillæ or several confluent papillæ (hence often truncate and tuberculate at the apex), placed in the middle of the cell; cells mostly full of chlorophyll, sometimes with a primordial utricle, often very small and thickened. Capsule erect, rarely inclined, oval, elliptic or pear-shaped oblong, smooth or striate, the operculum mostly conical or beaked.

This family is divided into three tribes:

1. Calymperaceæ. Basilar cells of the leaves rigid, hyaline, often very brittle, more or less ample, empty, distinctly foraminated.

2. Pottiaceæ. Basilar cells of the leaves soft, pellucid, longer, mostly empty, rarely containing a persistent primordial utricle.

3. Orthotrichaceæ. Basilar cells of the leaves with only the very lowest soft, the upper mostly thickened, rarely pellucid and normal.

PRASI'OLA, Meneghini.—A genus of Ulvaceæ (Confervoid Algæ), separated from *Monostroma*, Thuret, by the arrangement of the quadrigeminate cells of the frond in lines, with wide intercellular walls; from *Ulva* by the existence of only a single layer of cells, and from both by the absence (?) of a reproduction by zoospores; from *Schizogonium* by the frond consisting of expanded plates. The species are included under *Ulva* (the terrestrial forms) in the *Brit. Flora* and Harvey's *Algæ*, ed. 1. They have recently been examined by Jessen, who finds the fronds proliferous at the margins; the 'spores' he describes as consisting of motionless cells formed of the entire contents of the cells of the frond, set free by the solution of the parent cell. The reproduction of this group seems to us to require further investigation. Jessen includes here the British species, *P. calophylla*, *crispa*, *furfuracea*, and a form which he names *P. stipitata*, differing from the last chiefly in the narrowly wedge-shaped, stipitate character of the frond: probably the last three constitute only varieties of one species. Probably it is not an independent form, but rather a part of the life-cycle of *Lyngbya*.

Bibl. Jessen, *Prasiolæ Monog.*; Kiliæ, 1848; Harvey, *Brit. Alg.* p. 171; Hassall, *Brit. Fr. Alg.* p. 297, pls. 77, 78; Kütz. *Sp. Alg.* p. 472; Rabenht. *Fl. Eur. Alg.* iii. p. 288.

PREPARATION of microscopic objects for examination and preservation.—Some remarks on the former point will be found in the Introduction; and under many of the general articles, such as Diatomaceæ, Coal, Ovule, Rocks, &c., special directions are given.

There are some microscopic objects, such as minute shells, foraminifera, crystals, and small vegetable organisms, which require but slight preparation before examination under the microscope; and placing them on a slip of glass before subjecting them to transmitted or reflected light is sufficient. The greater number of the small Algæ and Infusoria require an equally simple management; for by placing them on a glass slide with a small quantity of their natural medium, their general construction can be easily elucidated. But as nearly every microscopic object possesses interesting internal structures, it is necessary that some plan or other should be adopted to render them visible under the higher powers of the microscope without destroying or altering them too much. Great ingenuity has been displayed in this art of preparation of structures; and in fact in many instances the preparation for examination is as important as the correct application of the optical instrument. On the other hand, there is no doubt that portions of animal tissues may be and have been submitted to such complicated chemical processes, that although transparency of some and opacity or colouring of other portions render the labour of microscopist easy, still the whole bears but slight resemblance to the original substance. It is this alteration in the structures, pro-

duced by chemical reagents, which causes the diversity of opinion respecting the construction of many organs and tissues, and which has produced controversies sufficiently bitter; and hence it is necessary to examine the structures before submitting them to chemicals, and to learn to discriminate the portions which are preserved and rendered more apparent, and those which are destroyed more or less by the manipulation. So far as animal tissues are concerned, one thing must be always remembered; namely, most cells and even many structures in which the cellular element is scanty, undergo a change soon after death, and this physico-chemical alteration is rendered more intense and rapid if they are subjected to mechanical interference or are placed in media which do not resemble those in which they existed during life. It is only necessary to examine the aquatic larva of an insect whilst it is alive and in its proper element, and then to repeat the examination a few minutes after death, in order to appreciate the dulness and contraction or expansion of the tissues. Moreover, after placing the larva, before this decomposition has time to develop, in any medium besides water, the changes produced are seen to be very striking. Evidently, then, post-mortem changes soon occur in tissues; and solutions or media modify them more or less. It is necessary to allow for these results of manipulation and death, and to select such methods of preparation as do not alter the tissues too much or place them under very unnatural conditions. In dissecting animal structures, a medium should be used which resembles the fluid which permeated them during life, and not one which differs sensibly from their cell-contents. Hence the value of serum or allantois fluid, with or without a small quantity of iodine in it (*iodized serum*), or of the aqueous humour of the eye as media, and the unadvisability of employing water, except in particular cases. Glycerine in solutions of different strengths, sugar and water, and salt and water act as useful media in the examinations of both the animal and vegetable tissues, upon the same principle. Moreover the dissection should be conducted without bruising and too much tearing, and, if possible, under the surface of the medium. Hard structures may be manipulated irrespectively of media; but, as will be noticed, it is necessary to consider those which will render them transparent without producing much structural change.

The preparation of soft and hard structures for the microscope may be considered under four heads:—1. Dissecting, teasing, and pencilling out soft structures. 2. Section-making of soft tissues with preparatory hardening and subsequent alterations in the transparency and colour. 3. Section-making of hard substances. 4. Staining tissues.

1. It is not necessary to explain the process of dissection requisite to obtain a small portion of tissue of an animal or plant which is to be examined, but to state that the appliances are mentioned in the INTRODUCTION. The portion to be examined, if it does not form an opaque solid mass, may be placed on a glass slide in a medium, and a piece of thin glass carefully put upon it with more or less compression according to circumstances. If the transparency is sufficient, or the object is to be examined as an opaque one, the slide may be placed under the object-glass at once; but should the object be not sufficiently transparent, or should its histological elements be too crowded, then another portion should be placed in a drop of the medium, and seized and torn with needles until it is more or less *teased* out. Sometimes maceration is requisite before this can be done properly, and the tissue must be left for a greater or less time in the medium under cover. The teasing should be conducted under a dissecting microscope; and care must be taken not to produce such distortion and destruction of tissue as may be taken to be natural. In manipulating some tissues rather blunt-pointed needles are useful, and the structures are pressed out and unfolded without solution of continuity; such a method is pencilling out. When the elements of the structures have been sufficiently broken up, separated, or flattened out, they should be examined with a low power, and any pieces crossing each other should be removed; and notice should be taken of any unusual cell-structures in the *débris*. Then the objects should be washed with fresh medium, and the thin glass cover should be put on without any pressure being employed. Media may be introduced subsequently by placing drops of them in contact with the edge of the thin glass cover; and evaporation may be prevented by adding a very small quantity of oil to the edge of the thin glass. Soft structures thus prepared may be preserved or may be subjected to compression,

in order to render some portions more transparent. The media are of two kinds—those which are necessary for perpetuating the normal appearance, and those which produce transparency with or without acting like the first kind. Serum with or without iodine, the amnion fluid of any animal, and the humour of the eye, saliva and albumen of egg for animal structures, and syrup and water, gum and water for vegetable tissues are of the first kind; and glycerine in water and solution of chloride of calcium are types of the second. The macerating fluids are those just mentioned, and, for animal structures, solution of potash, hydrochloric acid, bichromate of potash, Müller's fluid, and baryta water. Muscular fibre macerates well in very dilute sulphuric acid. The teasing out may be done very effectually on a glass slide on which there is a film of gutta percha; and the dissecting minute portions of plants, such as the rudimentary flower buds, is rendered easy by placing them in pure glycerine as recommended by Beale.

Sections of the soft structures of animal and vegetable organisms can sometimes be made successfully, and of sufficient delicacy to be examined with moderately high powers, by means of the scalpel, razor, Valentin's knife, Stirling's microtome, or with a fine pair of scissors. Moistening the cutting instrument with one of the media already mentioned is necessary; and, unless in the case of plants and some aquatic animals, water should be avoided. It is always difficult to avoid dragging and crushing during the incision; but when the section is made it should be floated off on to a glass slide on which there is a drop of some proper fluid. The thin glass cover is then applied. If the section should require it, from being of irregular thickness, or from having much extraneous granular or cellular tissue about the cut surfaces, slight dissection with a sharply ground needle or fine scalpel will be necessary, and washing either with a direct stream of liquid or by placing the substance in a test-tube half filled with the medium and shaking it. After a thin section is completed and the thin glass applied, any reagents may be introduced under the edges with a view to obtain transparency, or the reverse, of the whole or of parts. Should the section have been made according to Beale's plan, out of a soft substance which had been kept in glycerine, a weak solution may be applied first of all and then stronger. Some soft tissues, after being cut, may have a concentrated solution of the chloride of calcium applied, and the thin glass cover put on; and they will last a long time without further mounting.

In order to prevent the deranging effects of section-cutting on some soft animal tissues, it is an excellent plan to fix them in some soft substance which can be cut with them—such as transparent soap, carrot, or tallow. The following is recommended by Rutherford and Ferrier:—solid paraffine 5 parts; spermaceti 2 parts; axunge 1 part, or a mixture of bees-wax and olive-oil. Tissues to be imbedded should be as dry as possible, or else the supporting substances will not cling to them; and the water or fluid may be got rid of by placing them in alcohol for a short time. Very delicate tissues which contain much connective tissue, may be imbedded according to Stricker's plan in gum. The specimen should be placed in alcohol of ordinary strength for twenty-four hours, and then removed into a paper cone filled with a very concentrated solution of gum; the whole cone is then immersed again; and in the course of a few days the gum will be found to have attained a consistence which renders it fit for sections to be made. Rutherford suggests that the cone should be placed in paraffine or in the substance of a carrot before the sections are made. In order to produce clear, equal, and thin sections, Stirling's microtome should be used. It is a brass plate or table having a hole in the centre. The hole communicates with a tube, at the bottom of which is a screw. The tissue is placed in the tube; and the paraffine mixture is poured round it, or it is imbedded in a piece of carrot cut to fit the tube. The imbedded mass is elevated by the screw, and a razor is placed on the plate and pushed by the hand obliquely through the tissue projecting from the hole. The screw is graduated. The knife is wetted; and all the sections are floated off it on to the glass slide, and should be manipulated with sable or camel's-hair brushes. A drop of glycerine should be placed on the slide; and after examination the preparation may be mounted by removing the excess of fluid with blotting-paper, and placing asphalt varnish round the edges of the thin glass. Or the sections may be placed in alcohol, and then in oil of cloves, and taken therein to the slide, on which there is some Canada balsam or gum dammar.

The most elegant method of preparing soft tissues for section-making without the application of hardening reagents, is by combining a freezing-apparatus with the microtome just described. Rutherford and Turner have devised a plan by which pounded ice and salt surround the tube and freeze the tissue, which is imbedded in gum-water, for instance; sections are then made.

2. Numerous chemical solutions have been used to harden tissues prior to making sections of them; but the best are as follows:—The tissue, cut into small pieces, is placed in absolute alcohol, which is renewed according to the quantity of water in the objects. Membranous tissues may be boiled in vinegar, or in a fluid consisting of 8 parts water, 1 part creosote, and 1 part vinegar. The boiling should continue for three minutes, and the specimen should be allowed to dry. The sections should be treated with a little dilute acetic acid and then with glycerine. For nervous matter, chromic acid in a solution in water containing 0·25 to 2 per cent. Alcohol should be added on removal from solution if haste is required; and in all cases the objects should not be too large.

The sections made from the objects thus hardened require to be rendered transparent with glycerine, turpentine, or clove-oil, and they may be mounted in glycerine, dammar, or Canada balsam. Müller's fluid, which consists of $2\frac{1}{2}$ parts of bichromate of potash, 1 part of sulphate of soda, and 100 parts of distilled water, requires from three to six weeks to harden the retina and eye generally. Osmic acid, 1-10th to 1-5th per cent. in distilled water, hardens rapidly; and the tissues should be placed afterwards in distilled water, and mounted in solution of acetate of potash.

The usual plan of hardening portions of the nervous tissue with dilute solutions of chromic acid is excellent; but a new plan has been suggested and practised by Betz, of Kieff, who places the brain and cord, deprived of their membranes, in alcohol and iodine enough to colour them a light brown; subsequently the mass is placed in a solution of bichromate of potassium. Large sections may be made out of the brain thus hardened. Weak spirit and iodine are used for the brain, and the pia mater is taken off gradually, and then the mass is returned to fresh spirit and iodine, and then stronger alcohol is added. Before cutting preparations made in this manner, the bichromate must be got rid of by much washing, and the knife must be moistened with alcohol. They stain very readily. See STAINING.

For preparations with *Chloride of Gold, Nitrate of Silver*, &c., see STAINING.

Beale uses a solution of chromic acid in glycerine, the small quantity of the acid being sufficient to give the glycerine a pale straw-colour. His solution of bichromate of potash contains 20 drops of a saturated solution of the bichromate in water added to 1 oz. glycerine. They are admirable nerve-hardening agents. Gerlach recommends a solution of 1 to 2 per cent. of double chromate of ammonia in water, to harden nervous structures prior to the staining with chloride of gold with or without chloride of potassium; and he also advises perfectly fresh spinal cords to be cut in thin sections, and to be placed in sol. bichr. ammon. 1 in 5000 to 10,000 water. After three or four days they are immersed in a very dilute solution of carmine and ammonia for twenty-four hours. They are then teased or broken up, and mounted either in glycerine or, after drying, in Canada balsam after oil of cloves has been added.

In rendering sections transparent with glycerine, Price's may be used in combination with 5 drops of glacial acetic acid to the ounce (Beale). When acetic acid is used, it is the ordinary pyroligneous acid, and the solution of soda employed is made of 1 part caustic soda and 20 to 30 parts of water. These solutions mix with water, and are therefore employed to clarify tissues from which all water has not been removed. But the turpentine, oil of cloves, and other essential oils do not mix with water, and therefore they can only act on tissues hardened by immersion in alcohol.

Sections of vegetable tissue can be floated on to the glass slide with weak solution of gum, sugar, glycerine, spirit of wine, or camphor-water; and they may be kept in these solutions, except in those which contain gum and sugar.

3. *Sections of hard or easily held vegetable tissues.*—Fresh stems of plants, thick leaves, &c. may be simply held in the fingers; thin objects, such as leaves, petals, &c., are best placed in a split cork or carrot, the halves of which are kept together by insertion in the neck of a phial or a test-tube, which at the same time serves as a handle. Sometimes it is advantageous to immerse them, especially soft or very small ones, in

thick mucilage of gum-arabic, and to allow this to dry until tough enough to be cut by the razor; the slices are freed from gum by immersion in water. Dry objects, such as wood, dried leaves, seeds, &c., must be softened by soaking in water before slicing. Small firm objects, such as seeds, are most easily sliced when fixed in a bit of white wax or stearine, which may be done by placing them on the surface of the latter, and stirring them into the substance melted by the application of a hot wire. Most slices of vegetable objects are obscured by air-bubbles engaged in the intercellular passages, &c. In old wood and similar objects the air is readily driven out by heat; in fresh structures, where heat may coagulate or dissolve matters, the air may be allowed to dissolve or escape by itself, which requires time, or may be removed by exhaustion. A substitute for a regular air-pump may prove useful to the microscopist, consisting of a piece of thick and stout glass tube, closed at one end, containing a tight-fitting piston, with a valve opening upwards; the object being placed in water (or other liquid) at the bottom, a single raising of the piston, or at all events, two pulls, will draw out all the air, and the water will take its place. This apparatus may be used also for saturating dry objects with oil of turpentine (for mounting in balsam), or with oil (to produce transparency).

Sections of woods &c. which are to be mounted in liquids, should be soaked for some little time in spirit or turpentine, to remove resins &c. A special apparatus is made for slicing such objects; but this is not of much use except when large numbers of very perfect sections of the same kind are required for the purpose of sale, &c.

It need scarcely be said that sections require to be made in various directions in studying objects by these means. Thus stems should be sliced horizontally, and perpendicularly both parallel to the medullary rays and at right angles to them, &c. When working with high powers, it is necessary to be on our guard against appearances of striation or fibres which may be produced by the fine notches in the cutting instrument.

The structure of laminated shells, &c. may often be seen in fragments broken off by the point of a knife. But sections of shell, bone, &c. are best made by sawing off thin pieces with a frame-saw having a watch-spring blade, grinding them down upon a water-of-Ayr or some other stone, and polishing them upon a clean leather hone or strop with putty-powder and water, finally upon a dry hone alone.

Sections of very hard substances, as agate &c., are so easily made by jewellers, that a description of the process is scarcely necessary. They are made by means of a circular iron plate, made to rotate by a lathe, its margins being coated with a mixture of oil and diamond dust. They are then ground upon a plate of metal with emery-powder and water, and polished upon a flat surface of pitch with putty-powder and water.

In grinding and polishing sections of hard structures, it is often requisite to cement them to a slide with Canada balsam, heat being applied until the balsam has become so hard as to fix the section firmly to the slide. As soon as one side has been polished, the section is removed from the slide, the balsam being rendered soft by heat, the polished side cemented to the glass, and the other side polished. The balsam may afterwards be separated from the section by maceration in oil of turpentine, ether, &c.

4. *Staining sections and tissues.* See art. STAINING and DYEING.

Besides these methods of preparation, there are those which enable the observer to keep sections or minute plants and animals under continuous examination without becoming dry, to provide a proper and equable or even higher temperatures to parts or the whole of organisms, and to add gases to the fluid surrounding the object. Recklinghausen's moist chamber fulfils the first requirement; and Stricker's slide, which is heated by means of the galvanic current, is most useful in producing constant amounts of heat. Stricker's gas-chamber, slide, and its conducting tubes enable carbonic anhydride, oxygen, hydrochloric acid, or any other gas to be applied to the fluid under examination. The warming-slide is particularly useful (although a less satisfactory and more unmanageable apparatus may be arranged, by heating a metallic end of the glass slide) in all examinations of the blood, pus, and ciliary motion, and especially when amœboid movements have to be watched.

BIBL. Beale, *How to Work &c.* 4th edit.; *Phil. Trans.* June 1863 & 1864; Carpenter, *The Microscope*; Frey, *Das Mik.*; Stricker, *General Methods, in Stricker's Hum. & Comp. Hist. Syd. Soc.*, tr. Power; Gerlach, *in Stricker*; Rutherford, *Qu. Mic. Jn.* 1872,

. 1; Woodward, *The Lens*, July 1872; Mouchet, *Mo. Mic. J.* iii. p. 75; Flemming, *in Max Schultze's Archiv*, ix. p. 123; J. Grönland, M. Cornu, and G. Rivet, *Des Prép. Micros.* (*Botanical*), Paris, 1871, *abstracted in Qu. Mic. Jn.* 1872, p. 82; Lochart Clarke, *Phil. Trans.* 1851, *and in Beale's How to Work*, p. 145; Moseley, *Qu. Mic. Jn.* 1872, pp. 374, 379; Urban Pritchard, *Qu. Mic. Jn.* 1872, p. 380; Ranvier, *Archives de Physiol.* 1872, p. 427; Betz, *Max Schultze's Archiv*, ix. p. 101; *Qu. Mic. Jn.* 1873, p. 343.

PRESERVATION of microscopic objects.—Under this head we shall consider the arrangement of microscopic objects for permanent preservation, supposing that they have been prepared (PREPARATION) in such manner as to render this possible.

Dry objects, or those which exhibit their structural peculiarities in the dry state.—These are sometimes mounted alone, at others when immersed in some preservative compound.

1. In the dry and uncovered state, they are occasionally mounted upon disks of cork, leather, or pasteboard, the surface upon which the object is to be placed being blackened by a coating of very fine lamp-black mixed with warm size or gum-water, or by a piece of dull black paper pasted upon it; the simplest way of making the disks is to paste black paper upon thick soft leather, and cut out the disks with a punch, like gun-wads. The object is fastened to the disk with a little solution of marine glue in naphtha, or with gum. The disks are sold in the shops. They are usually transfixed with a pin, by which they may be fixed in the forceps under the microscope, and may be fastened to the bottom of a box lined with sheet-cork when not in use. The advantage of this plan is its simplicity; its greater disadvantage, however, is that the objects are liable to injury, and become covered with dust. It answers very well for common objects, seeds, minute lichens, &c.; but when the objects are of value, they should be mounted in a cell.

2. The cell may be made of a square piece of card-board or pasteboard, of suitable thickness, with a hole punched in the middle, fastened to a slide by marine glue or Canada balsam—the object being fixed to the slide by a little of either of the above cements, and a thin glass cover cemented to the card-board. Or the whole may be fastened together with paste—first a piece of black paper upon the middle of the slide, then the perforated square, next the object, and lastly the cover. The square of pasteboard may be replaced by a glass ring, a perforated square of glass, or a piece of sheet gutta percha.

3. When the objects are minute or very thin, the square of pasteboard may be dispensed with, and they may be mounted thus: they are to be laid upon a slide, and a cover of thin glass placed upon them; a piece of paper larger than the cover, with a portion cut from the middle larger than the object, is then covered with paste, and a minute or two allowed to elapse, that the paper may become thoroughly imbued with it, the superfluous paste being removed with the paste-brush; the paper with the pasted side downwards is then laid upon the cover and the adjacent portions of the slide, and gently pressed with a cloth, that it may be accurately applied to the glass surfaces. The whole is then allowed to dry. The principal point in this process is the complete removal of the superfluous paste before the paper is applied. If this be not effected, it will be drawn by capillary attraction between the cover and, the slide, and reaching the object, will spoil it.

4. A very secure method of mounting dry objects which are not altered by heat, consists in laying a ring or square of black japan upon a slide, the thickness of the layer being adapted to that of the object, and applying a pretty strong or long-continued heat until the cement becomes perfectly hard when cold. The object is next placed within the ring, a cover laid on, and heat applied until the cement becomes liquid. Gentle pressure then brings the cement and the margins of the cover into contact; and when the cement becomes cold, the cover is firmly fixed to the slide.

5. Another method of fastening the cover to the slide is by the use of electrical cement and balsam (CEMENTS, p. 145) mixed with 1 or 2 parts of tallow.

6. Many dry objects can be well preserved by

Mounting in Canada Balsam.—When this is to be done, care must be taken that they are thoroughly dry; otherwise they will acquire a milky appearance, from being surrounded by minute drops of water. Some objects in drying curl up or become deformed, although their minute structure may not be essentially changed; this may be prevented by confining them between

two slides tied together with thread, or held together by india-rubber rings, sealing-wax applied at the two ends, or by a folded strip of brass with the ends riveted. If the objects be of tolerable size, they are then soaked in oil of turpentine kept in an ointment-pot covered with a lid, for some hours, or even days, until the air is entirely displaced from them by the turpentine. The latter will often also remove the colouring-matter from some objects, as parts of insects, which may or may not be desirable; hence the duration of the process must vary accordingly. A clean slide is then warmed over the flame of a spirit-lamp, or upon a stove, and some clear balsam placed in the middle of it, and rendered more liquid by further gentle heat; the object is then carefully removed from the turpentine with forceps, drained, and laid upon the warm balsam. Some more balsam is then allowed to fall from the warmed wire (BALSAM) upon the object; and when this is well covered with it, a warmed cover is gently laid upon its surface. The superfluous balsam then escapes at the sides of the cover; and this should be aided by gentle pressure. The slide is next maintained at a gentle heat upon a warm mantelpiece, or a piece of tin-plate, until, when allowed to cool, the balsam is perfectly hard. As soon as this is the case, the superfluous portions are cut away or scraped off with a knife, the surfaces of the glasses cleaned from any residue by a cloth wetted with oil of turpentine, and some sealing-wax varnish applied to the edges of the cover and the adjacent portions of the slide.

7. The success of the operation depends mainly upon two circumstances, viz. the object having been thoroughly dried, and the exclusion of air-bubbles. The former constitutes no difficulty, time being all that is required; but the latter requires that the object shall previously have been thoroughly moistened with the turpentine, and that the balsam shall have been added to the object, when laid in the balsam upon the slide, before so much of the turpentine has evaporated as will allow air to enter any minute cavities in the object. The heat applied should also be gentle; and if the direct flame of a spirit-lamp be used, its application should be made rather to some portion of the slide near that upon which the object is placed, than directly beneath the object. If much heat be applied, bubbles of the vapour of the turpentine will often disfigure the object for a time; but these will vanish as the object becomes cool.

If air-bubbles have found their way into the object, the slide must be macerated in oil of turpentine until the balsam is dissolved and the object liberated, and a fresh mounting made. The solution of Canada balsam in chloroform is very readily managed, and the difficulty with the air-bubbles is greatly lessened.

8. If the object be large, it must be mounted in a cell. A glass ring (sold in the shops) of suitable thickness must first be cemented to the slide by balsam; more balsam is then added until the cavity is filled, the object next added, and the cover applied.

9. If the object be minute, its removal for maceration in the turpentine is not requisite, and might entail the loss of the object. It must then be laid upon a slide, a drop or two of turpentine added, and the whole warmed until no air-bubbles are visible. The cover is then removed, most of the turpentine drained off, balsam added from the warmed wire, and the cover applied as before; or balsam may be placed upon the slide near the margin of the applied cover; and on applying a continued gentle heat it will find its way under the cover, and replace the turpentine as it evaporates.

10. If air-bubbles remain in parts of a minute object, a cover should be applied, turpentine added, and the slide held over a lamp until the turpentine boils, and the bubbles disappear on cooling. The cover is then removed, most of the turpentine allowed to evaporate, the balsam added, and the cover re-applied. Gum dammar used in the same manner as Canada balsam is excellent.

11. *Gum and Glycerine.*—Objects which cannot be conveniently dried may be mounted in a solution of gum-arabic in glycerine; the manipulations are much the same as with balsam, except that no heat is required. *Glycerine jelly* is often used.

12. *Mounting in liquid.*—The structure of many objects is so altered by drying, that they require to be mounted in some preservative liquid. These, if of considerable size, must be mounted in glass cells.

13. The cells may consist of glass rings, *i. e.* portions cut transversely from pieces of glass tubes, of various sizes, according to the dimensions of the objects. In using these, the ring is first warmed in the flame of a spirit-lamp, being held by steel forceps; one of the ground surfaces of the ring is then

covered with marine glue or balsam previously melted in the same flame; the surface of the slide to which the ring is to be cemented is then heated in the flame, and whilst it is hot the surface of the ring coated with the melted cement is applied to it, and the ring pressed firmly, so as to displace the superfluous portions. When cold, these are to be removed with the point of a knife; sometimes a little solution of potash, oil of turpentine, or naphtha is required for this purpose. The cell is then complete, excepting the lid or cover, which consists of a circular plate of thin glass, of slightly less diameter than that of the outer margin of the glass ring. The cell is now to be filled with the preservative liquid, the object placed in it, and the cover applied, being made to slide over the upper surface of the ring, so as to displace any excess of liquid, and prevent the admission of air-bubbles. If the quantity of liquid at first put into the cell be not sufficient, more must be added, until slight excess is present; the superfluous portions may be removed by a piece of blotting-paper, and the margin of the cover and ring very carefully wiped clean with a silk handkerchief, so that the surfaces may be free from all traces of the preservative liquid. The exposed parts of the upper surface of the glass ring, and the adjacent margins of the cover, are then to be coated lightly with one of the liquid cements, by means of a camel's-hair pencil; and when the first coat is dry, another must be laid on, so that the edges of the cover and the adjacent parts of the glass ring may be firmly cemented together, and the cell completely closed, so that no evaporation of the contained liquid can take place.

The important points in this process are, that the heated cement used to fasten the ring to the slide must accurately coat every portion of the two surfaces in apposition, and that the surfaces to which the liquid cement is applied must be perfectly clean and dry, so that the cement may come into contact with the surfaces of the glass. Rings of india-rubber and gutta percha are very useful instead of glass.

14. When the objects are very large, the rings may be conveniently replaced by cells constructed of slips of glass, arranged so as to constitute four sides of a box, the bottom of the box being formed by the slide, and the top by a plate of thin glass: the pieces should be cemented together by marine glue.

15. Smaller cells may be made with marine glue, melted, dropped upon a slide and flattened whilst warm with a piece of wetted glass, the superfluous portions and central portion cut away with a knife. Should the marine glue become loosened from the slide, it may be re-fastened by heat; and if the upper surface be not perfectly flat, it may be made so by grinding with emery-powder and water upon a plate of metal or upon a stone.

Minute objects may be mounted in liquid in a variety of ways, the choice of which will vary with their nature. They are generally mounted in shallow cells, the sides of which are formed by varnish.

16. The old method consisted in placing the object upon a slide, adding a drop or two of the preservative liquid, applying the glass cover, adding more of the liquid, or removing excess with blotting-paper, until the space between the slide and cover was accurately filled, then applying to the margin of the cover and the adjacent portions of the slide a coat of some liquid cement, as gold-size, asphalt solution, black japan, &c. Objects thus mounted keep well for a time; but the cement soon apparently runs into the space between the cover and the slide, and the object becomes spoiled. It is often requisite, however, to mount an object in this way, which may be lying upon a slide, perhaps in some peculiar position which it is important for it to retain; when this is the case, the electrical cement with balsam and tallow (PRESERVATION) should be used; and there is less fear of change, provided spirit be not used as the preservative liquid.

17. Whenever it is possible, then, a cell-wall should be previously formed, by laying a ring or square of one of the liquid cements upon the slide with a camel's-hair pencil, and applying a continued heat until it becomes thoroughly hard when cold. The cements generally used are:—asphalt solution; gold-size with which a little finely powdered litharge has been well mixed, immediately applied, as it soon hardens; sealing-wax varnish; solution of marine glue in naphtha, or of Canada balsam in ether or chloroform, or the balsam alone. Allport's liquid marine glue is very useful. If the upper surfaces of the rings or squares formed of these compounds, when thoroughly dry and hard, be not perfectly flat, they may be made so by grinding alone, or with emery and water, upon a piece of metal,

marble, or a stone. The object is then placed in the cell, the preservative liquid added, and the cell closed as above described.

The following are the most important preservative liquids and compounds :—

Thwaites's liquid is thus prepared: to 16 parts of distilled water add 1 part of rectified spirit, and a few drops of creosote sufficient to saturate it; stir-in a small quantity of prepared chalk, and then filter. With this liquid mix an equal measure of camphor-water, and, before using, strain through fine muslin. Used by Mr. Thwaites for preserving freshwater Algæ, as having but little action upon the endochrome.

Ralfs's liquid.—Prepared with bay-salt and alum, of each a grain, distilled water 1 oz.; dissolve. Forms a readily prepared substitute for the former in the preservation of the Algæ (Desmidiaceæ).

Acetate of alumina.—1 part of the salt to 4 parts of distilled water. Mr. Topping finds this the best preservative for delicate vegetable colours.

Distilled water. — Very often used for preserving Algæ; but perhaps camphor-water would be better.

Camphor-water is prepared by digesting distilled water with a lump of camphor.

Spirit and water.—Proof-spirit may be prepared by mixing 5 measures of rectified spirit with 3 of distilled water. It is frequently used for preserving animal structures, organs, injections, &c. Delicate preparations may be kept in a mixture of 1 part of spirit with 5, or even 10, parts of water. Dilute spirit should never be used as a preservative when it can possibly be avoided, on account of its action upon the cements. Methylated spirit is very useful, on account of its cheapness and strength; may be used when diluted in preserving large specimens of animal tissue.

Creosote water is prepared by filtering a saturated solution of creosote in rectified spirit, mixed with 20 parts of water. It is recommended for preserving preparations of muscle, cellular tissue, tendon, cartilage, &c.

Arsenious acid.—A preservative liquid is made of this substance by boiling excess of the acid with water, filtering the solution, and adding 2 parts of water. It is a very good preservative of animal tissues.

Corrosive sublimate. — Harting recommends a solution of this substance as the best preservative for the corpuscles of the blood, nerve, muscular fibre, &c.; the strength of the solution must vary from 1 part in 200 to 500 of water, according to the nature of the object. Thus the blood-corpuscles of the frog require 1-400, those of birds 1-300, of mammals 1-200.

Salt (chloride of sodium) and water, 5 gr. to the ounce, was long since recommended for the preservation of tissues, but is not much used, because fungi are apt to grow in it, which might, however, be prevented by saturating it with camphor by digestion. M. Corti has found "a tolerably concentrated solution" the best preservative for the delicate structures and nerve-cells of the internal ear. Carpenter recommends sea-water, with one tenth part of alcohol and one tenth of glycerine, for preserving delicate marine organisms. *Solution of acetate of potash* is useful.

Carbonate of potash.—1 part dissolved in from 200 to 500 of distilled water, is a good preservative of the primitive nerve-tubes.

Arsenite of potash.—1 part dissolved in 160 of water has been found useful for preserving the primitive nerve-tubes.

Glycerine.—We have found this the most valuable of all liquids for vegetable preparations, which may be closed air-tight or not at pleasure. Dissections covered with a glass may be left in it from day to day, remaining unchanged and always ready for examination. Objects may be mounted in it as with chloride of calcium. It is one of the most valuable fluids for the preservation and preparation also of animal tissues. Camphor-water and naphtha and water may be added. Dr. Beale advocates strong glycerine as a medium for special organisms and for preservation.

Gelatine and glycerine is a valuable medium, and glycerine jelly also. See Lawrence, *Qu. Mic. Jn.* 1859, p. 257.

Hantzsch, of Dresden, quoted by Carpenter, produced a fine preservative medium for minute Algæ. A mixture is made of 3 parts of pure alcohol, 2 parts of distilled water, and 1 of glycerine; and the object, laid in a cement-cell, is to be covered with a drop, and placed under a bell-glass. Alcohol and water evaporate, and leave the glycerine: more is added time after time, and the cell is thus filled.

Glycerine and Gum.—Pure gum-arabic 1 oz., glycerine 1 oz., water 1 oz., arsenious acid $1\frac{1}{2}$ grain; dissolve the arsenious acid in the water, then the gum (without heat), add the glycerine, and incorporate with great care to avoid forming bubbles.

Canada balsam (See BALSAM, Canada).—When rendered thinner by digestion with a little ether at a gentle heat, it forms a liquid cement.

Canada balsam solution is useful in mounting many delicate structures. The chloroform solution is the best. Sufficient chloroform is added to make the mixture run freely. The balsam hardens with evaporation. Gum dammar is gradually superseding Canada balsam.

Gum-water (see CEMENTS).—The solution should be very thick, so as to flow with difficulty from the end of a wire. It may be used like balsam, but without heat. The residue is very apt to crack when dry; this may be prevented by applying a thick coating of varnish around its margins.

Chloride of calcium (CALCIUM, chloride of).—Objects may be mounted in this solution without closing the cell, by pasting two narrow strips of paper transversely upon a slide, leaving a greater interval than the breadth of the object; the latter is then laid upon the slide, a small quantity of the solution added, and a cover applied. The solution must not touch the paper. The cover may be fixed to the paper on the slide by the electrical cement with balsam and tallow. It is best, however, to close the cell.

Chloride of zinc in solution is too powerful an agency for any but large specimens.

Goadby's solutions.—These are of three kinds. The first (A) is made with—bay-salt (coarse sea-salt) 4 oz., alum 2 oz., corrosive sublimate 2 grains, boiling water 1 quart. This is too strong for most purposes, and is only to be employed where great astringency is required to give form and support to delicate structures.

The second (B) is made with—bay-salt 4 oz., alum 2 oz., corrosive sublimate 4 grains, water 2 quarts. This is recommended for general use, and as best adapted for permanent preparations. Mr. Thwaites uses it for marine Algæ; but we have found chloride of calcium answer for this purpose, and it is much more secure. Schultze recommends it for preserving *Medusæ*, Echinodermata, Annelid larvæ, Entomostraca, Diatomaceæ, Polythalamia, and Polycystina, both the hard and the soft parts, and advises the use of glycerine afterwards to produce transparence.

When carbonate of lime exists in the preparations, as in the Mollusca, the following (C) should be used:—take of bay-salt 8 oz., corrosive sublimate 2 grains, water 1 quart. Marine animals require a stronger liquid (D) of this kind, made by adding about 2 oz. more salt to the last.

Deane's compound.—This is made with—gelatine 1 oz., honey 5 oz., water 5 oz., rectified spirit $\frac{1}{2}$ oz., and 6 drops of creosote. The gelatine is soaked in the water until soft, and then added to the honey, which has been previously raised to a boiling-heat in another vessel; then boil the mixture, and, when it has cooled somewhat, add the creosote mixed with the spirit; lastly, filter through fine flannel.

When about to be used, the compound must be slightly warmed, and the object placed in a drop upon a previously warmed slide. The cover is then to be breathed upon and applied, taking care to exclude air-bubbles; a coating of black japan or Brunswick black around the margin completes the whole. Solution of naphtha and creosote water and chalk are useful for large preparations. Carbolic acid and distilled water, one part in one hundred, will suffice. It is very useful for vegetable preparations.

Chromic acid. See PREPARATION.

Soluble glass.—This compound, which is a solution of silicate of soda or potash, or of both, promises to become one of the best preservative liquids. It is used as glycerine, and in the course of a day or two becomes perfectly hard, retaining a beautiful glass-like transparency. Unfortunately all our specimens have become opaque, on account of the formation of crystals, apparently from the presence of too much alkali. When properly prepared, it will undoubtedly surpass all other preservatives, on account of its durability and extremely low refractive power, which scarcely exceeds that of water.

Saturated solution of chloride of calcium in water and solution of acetate of potash are very useful for the preservation and mounting of some substances. See PREPARATION.

That preservative liquid should always be chosen which exerts least action upon the structure of the object which it is required to preserve.

If drying the object does not destroy its peculiar structure, and the object is not very transparent, then balsam should be used.

If the structure be destroyed by the process of drying, and the object be not impaired by endosmosis, the chloride of calcium or glycerine is best. Other circumstances may render these preservatives desirable: thus the minute parts of the mouth of the Aca-

rina are best seen and preserved in balsam, whilst the general form of the body is best retained when the animals are immersed in chloride of calcium or glycerine.

Objects to be mounted in a preservative liquid should be placed in a watch-glass. If they are alive they may be placed in water; and as much of this as possible should be poured off, or removed with a pipette or blotting-paper, and the preservative liquid added, and this operation repeated that the water may be entirely displaced.

If objects be mounted according to the method described in § 15, p. 639, the electrical cement and tallow compound should be used; for if black japan or gold size be made use of, the objects will certainly be spoiled.

The liquid cements used to close the cell should be applied in several layers, each being allowed to dry before the next is applied.

The preservative liquid must not be capable of exerting any action upon the cements used in making or closing the cell.

If chloride of calcium or glycerine be used as the preservative liquid, when the first coat of liquid cement used to close the cell has become dry, the slide and cover should be washed gently with a sponge and distilled water, then dried with blotting-paper or a silk handkerchief, and the next coat of varnish applied.

The deeper the cell, the less the chance of the object being spoiled.

As soon as objects are mounted, the slides should be labelled with a square or circular piece of paper pasted upon them, the name and other particulars being expressed in writing. The name &c. may also be written upon slides with a diamond: but the paper labels should always be used; otherwise much time will be lost in searching for and distinguishing particular objects in the cabinet.

Bibl. Treatises upon the Microscope; Harting, *Het Mikroscop. Edinb. Monthly Journ.* 1852; Corti, *Sieb. and Köll. Zeit.* iii. 134; Griffith, *Ann. Nat. Hist.* 1843, xxi. 113; Tulk and Henfrey, *Anat. Manip.* 1844; Goadby, *Amer. Journ.* xiii. 15; Davies, *Naturalist's Guide*; Mohl, *Botan. Zeit.* xv. p. 249; Beale, *How to work*, 4th edit.; Carpenter, *The Microscope*; *The vols. of Qu. Mic. Jn. & Mo. Mic. Jn.*; Frey, *das Mik.*; Stricker, *Hum. Hist.*; Heys and Hepworth, *Trans. Mic. Soc.* 1865; Davies, *On Preparation and Mounting*; Lawrence, *Qu. Mic. Jn.* 1859, p. 257; Walmsley, *Mo. Mic. Jn.* i. p. 380; Bastian, *Mo. Mic. Jn.* i. p. 94; Mouchet, *Mo. Mic. Jn.* iii. p. 75.

PRIMITIA, J. & H.—A small fossil Ostracode, with suboblong valves, impressed with a variable furrow or pit in the medio-dorsal region. Forty species in the Silurian rocks of Britain, Europe, and America.

Bibl. Jones & Hall, *Ann. N. H.* 3. xvi. 415.

PRIMORDIAL UTRICLE (*utriculus primordialis*, *Primordialschlauch*). — This name came formerly into general use, at the suggestion of Mohl, to indicate a peculiar portion of the contents of the cellulose sac constituting a vegetable cell. By that author it was regarded as a distinct structure; by others its separate existence is doubted and denied; while it has been proposed by Pringsheim to transfer the name to a structure different in its nature from that which Mohl has described as his primordial utricle. As the formations comprehended under this name are of great importance in the development of vegetable cells, a little detail must be entered into in explaining this subject.

If a cell of the pulp of any succulent fruit, a cell of yeast, or cells in sections taken from the delicate nascent tissues of any growing part of plants, are placed in water, the entire contents will soon be seen to retract from the cellulose wall, leaving a clear space, filled with transparent liquid, between the latter and a sharply defined line bounding the contracted or coagulated contents (Pl. 38. figs. 1, 2, 10–12). The addition of tincture of iodine makes the conditions still more clear. If the parent cells of pollen-grains or spores are treated thus, just before the development of the cellulose wall of the special parent cells (see Pollen), the four portions of the contents of the parent cell contract and separate, and each portion, containing its own granular structures and nucleus, appears bounded by a well-defined line (fig. 607). This well-defined line presents in this condition the apppearance of a delicate membrane or pellicle enclosing the entire contents. The action of acids, or spirit, and iodine, reveals the existence of a similar set of conditions in all actively vegetating cells; and in most cases a more or less thick viscous layer of the protoplasm is found lining the cellulose wall before the application of the reagents. Since the line indicating the boundary of the contents cannot be distinctly seen until the contents have retracted from the cellu-

lose wall, and since the protoplasm is always coagulated by the action of the reagents, it

Fig. 607.

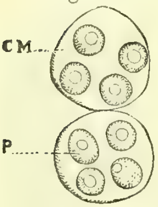


Fig. 608.

Fig. 607. Parent cells of pollen-grains just after the separation of the contents into four portions, treated with iodine. *C M*, the parent cell. *P*, the protoplasmic portions, each with a nucleus and a well-defined outline at the surface of the primordial utricle. Magnified 250 diameters.

Fig. 608. Cells of Protococcus multiplying. The green granular contents are bounded by the definite outline of the primordial utricle; the primary and secondary cellulose parent-cell membranes are represented as separated from each other. Magnified 400 diameters.

is a subject of discussion whether the film forming the well-defined line on the surface of the contracted contents is a true structure, or only a pellicle produced by the coagulation of the surface of the protoplasm, just as a " skin " forms over size, or other similar substances when they dry up in the air. There is great ground for believing the latter view to be correct; but the term *primordial utricle*, as used by Mohl, is applied to the protoplasmic layer lining the cellulose wall, whether it be merely a gelatinous investment in its natural condition, or a true membrane, because this formation, whether a membrane or merely a layer of viscid protoplasm, exerts in any case a special and most important function. Among the principal reasons for doubting the independent existence of a pellicular nitrogenous membrane, are the following facts:—Very young cells often appear filled with a dense protoplasm (young cells of antheridia of Cryptogamia, embryo-sacs of many flowering plants, cells about to produce zoospores in the Confervoids, &c.), which may produce numerous new cells by merely breaking up into separate portions; and thus the function of the primordial utricle is shared by the entire mass of contents. Young cells of nascent tissues, presenting this condition at first, acquire the so-called primordial utricle afterwards, simply by the dense contents becoming excavated, as it were, as the cell-wall expands, and following this in its growth, so that the originally dense homogeneous mass becomes a hollow sphere with the centre occupied by watery cell-sap; in other cases the originally homogeneous protoplasm becomes excavated by numerous water-vesicles, and thus honeycombed, until it forms a mere reticulation of protoplasmic threads upon the wall or stretched across the cavity. But the point is by no means clear at present. Indeed the protoplasmic layer lying upon the wall of the cell presents a complex arrangement of parts in some cases: A. Braun correctly distinguishes three layers in *Hydrodictyon*; there are three in *Chara*, where the intermediate one contains the chlorophyll-granules, and the innermost forms the circulating mass; a distinct layer is left after the discharge of the zoospores in *Cladophora*, &c. Pringsheim has lately asserted that he has coloured blue by Schultze's reagent the outermost layer of the pellicular structures detached from the cell-wall by acids &c. in the Confervæ; and hence he assumes that Mohl's primordial utricle is really the most recently formed of the layers of cellulose belonging to the permanent cell-wall, and that this is formed by a chemical transformation of the superficial stratum of the protoplasm. Possibly the last cellulose layer of thickening may be brought away from the wall by reagents; but it would cause a confusion of ideas to call this the *primordial utricle*, even if it be the pellicular structure seen under some circumstances by Mohl and others. The term properly applies to the formative stratum of all independently vitalized masses of protoplasm, capable of secreting layers of cellulose, which in the cavities of parent cells form layers of thickening or septa, or in a free condition the primary walls of new and independent cells. Thus, as explained under the head of Cell-formation, the primordial utricle or formative protoplasmic layer is the active agent in cell-division, and the layer forming the surface of the isolated portions of contents of parent cells produces the new cell-wall in all cases of free-cell formation, whether taking place in parent cells, or as in the case of the zoospores of Algæ, after escape from the latter.

In many of the Algæ, some of the individual cells regularly exist for a certain period as masses of protoplasm devoid of a cellulose coat, as, for example, the spores of *Fucus* and its allies, and the active zoospores of Confervoids; and these bodies, although presenting a well-defined outline, do not appear to have a properly developed mem-

brane on the surface, which merely appears to be denser than the semifluid central portion. These bodies withdraw themselves evidently from the definition of a vegetable cell as ordinarily given; and even the existence of a protoplasmic pellicle upon the surface of the *primordial utricle* cannot be shown; nevertheless they constitute all the essential living part of a vegetable cell, and indicate most clearly the undoubted fact that the cellulose walls (that is to say, all the really solid and permanent portions of vegetable structure) are mere skeleton or shell for the protoplasmic or nitrogenous structures. Cohn has proposed for the independently vitalized masses of 'cell-contents' the title of *primordial cells*; and they do correspond to many of the forms of the 'cells' of animal tissues, and of the 'unicellular' animal organisms, AMŒBA &c.: but none of these are really *cells* according to the original idea; hence the transfer of names causes confusion. Were not the name *nucleus* already taken for the supposed centre of vitality of these bodies, it would be applicable, as would be that of *cytoblast*; but as these are occupied, the name of *protoplast*, or, as Huxley proposes, *endoplast*, might be adopted, and certainly would be preferable to calling the bodies "primordial cells."

The relation of the "primordial utricle," or formative nitrogenous layer, to the SECONDARY DEPOSITS of cell-walls is not yet clearly ascertained. Crüger has recently asserted their essential agency in producing these, as will be noticed under that head and under SPIRAL STRUCTURES.

The protoplasmic substances indistinguishably connected with the so-called *primordial utricle*, are also the active agents in the ROTATION or circulation of the cell-contents. Further relations of these nitrogenous matters are also dwelt upon under CHLOROPHYLL and STARCH.

BIBL. Von Mohl, *Botan. Zeit.* ii. p. 273 (1844); *Vermischte Schrift.* p. 362; Henfrey, *Ann. N. H.* xviii. p. 364; Nägeli, *Zeitschr. f. wiss. Bot.* Heft 1 (1844), & 3, 4 (1846); Alex. Braun, *Verjüngung, &c.* (trans. in *Ray Soc. Vol.* 1853, p. 121 *et seq.*); Cohn, *Nova Acta*, xxii. p. 605, transl. in *Ray Soc. Vol.* 1853, p. 517; Pringsheim, *Bau u. Bild. d. Pflanzenzelle*, Heft 1. Berlin, 1854; Hartig, *Botan. Zeitung*, xiii. p. 393 *et seq.* 1855; Crüger, *ibid.* p. 601; Mohl, *ibid.* p. 689.

PRITCHAR'DIA, Raben.—A genus of Diatomaceæ which includes some species of *Nitzschia* and *Synedra*. *N. scalaris*, Smith, *N. insgnis*, Greg., *N. virgata*, Rosser, and *N. Smithii*=*N. spectabilis*, Smith, are included.

BIBL. Rabenht. *Fl. Eur. Alg.* i. 162.

PROEMBRYO.—The term applied to the structure first produced from the germinal vesicle of Flowering Plants, after impregnation, consisting of the suspensor and the embryonal cell at its extremity. The proembryos of the Gymnosperms are especially remarkable (see OVULE). The same term is often incorrectly applied to the PROTHALLIUM, the cellular structure first produced in the germination of the spores of the higher Flowerless Plants.

PROROCEN'TRUM, Ehr.—A genus of Peridinina, cilio-flagellate Infusoria.

Char. The transverse groove is absent; cilia are present, and also a single flagelliform filament.

P. micans (Pl. 24. figs. 70 & 71), ovate, greatly compressed; length 1-430".

BIBL. Ehr. *Infus.* p. 44; Clap. et Lach. *Etudes*, p. 411.

PROR'ODON, Ehr.—A genus of Infusoria, of the family Trachelina.

Char. Body covered with vibratile cilia, truncate in front; mouth with a cylinder of teeth. Aquatic. Species numerous.

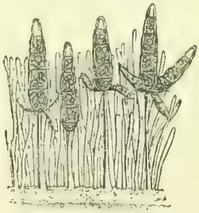
P. teres (Pl. 24. fig. 72). Body ovate, terete, white. Length 1-140".

BIBL. Ehr. *Infus.* p. 315; Clap. et Lach. *Etudes*, p. 318.

PROSEN'CHYMA. See TISSUES, Vegetable.

PROSTHE'MIUM, Kunze.—A genus of Melanconiei (Coniomycetous Fungi), growing upon the branches of trees, forming circular depressed spots; the perithecia

Fig. 609.



Prosthemium betulinum.
Spores and paraphyses seen in a vertical section of fruit.
Magnified 200 diams.

enclose erect articulated filaments bearing radiating tufts of two or three septate spores (fig. 609). *P. betulinum* occurs upon the

bark of the branches of the birch-tree. The species are mere forms of *Sphæriacei.*

BIBL. Berkeley, *Brit. Flor.* ii. pt. 2. p. 297.

PROTAMŒ'BA, Haeckel.—A genus of Protista.

Char. A simple shapeless protoplasm-body without the formation of vacuoles, which protrudes simple processes, not ramifying or anastomosing, and which reproduces itself by fission.

Species. *Protamœba primitiva.* Protoplasm-body of 0·03–0·05 millim. diameter, continually varying in form, with one or several (3 to 6) peripheral pseudopods. Processes short, rounded, obtuse, finger-shaped, at most as long as the diameter of the central body.

Locality. A pond of fresh water, near Jena.

BIBL. Haeckel, *Generelle Morphologie*, 1866, vol. i. p. 133.

PROTEA'CEÆ.—A family of Dicotyledonous plants, mostly from New Holland or the Cape, shrubs or small trees (*Banksia, Grevillea, Hakea,* &c.), of remarkably rigid, evergreen habit. The coriaceous leaves are well suited for the study of the epidermal structures; and the stomata have interesting peculiarities (see STOMATA). The epidermis is often scurfy with scattered hairs, some of which are of curious forms (Pl. 21. fig. 29).

PROTEINA, Claparède et Lachmann.—An order of Rhizopoda, including the families Amœbina and Actinophryna.

BIBL. Clap. et Lach. *Études*, p. 434.

PROTEON'INA, Williamson.—A simple arenaceous Foraminifer, probably belonging to *Lituola.*

BIBL. Williamson, *Rec. Foram.* 1; Carpenter, *Introd. For.* 309.

PROTEUS.—An old name applied to certain Infusoria, as *Amœba* &c.

Also a genus of Amphibia with large blood-corpuscles.

PROTHAL'LUS OR PROTHALLIUM.—The structure which is the result of the germination of the spores of Cryptogamia, and in which the female, and sometimes the male organs are formed. See MARSILIACEÆ, LYCOPODIACEÆ, EQUISETACEÆ, FILICES. Fankhauser (*Bot. Zeit.* 1873, pp. 1–6) has discovered the prothallium of *Lycopodium*; it is subterranean and destitute of chlorophyll. A vertical section through it shows that the cellular structure is formed of three layers: the uppermost, in which the archegonia and antheridia are developed, consists of thin-walled cells, poor in cell-contents the cells of the middle layer are smaller, and their contents are dark and granular; and those of the innermost layer are somewhat elongated and parallel to the surface, their contents being turbid and finely granular.

BIBL. Henfrey, *Elem. Course* (Masters); Fankhauser, tr. M'Nab, *Qu. Mic. Jn.* 1873, p. 299; B. Sanderson in *Todd's Cycl. Anat. and Phys.* art. *Reprod. Veget.*

PROTISTA, Haeckel.—A kingdom of organic nature which is intermediate between the animal and vegetable kingdoms, and which comprises the so-called lowest forms of life. The organisms included in the Protista reproduce themselves not in a sexual manner, but by monogony. It is divided into the following groups:—

- I. Monera.
  1. Gymnomonera (*Protogenes, Protamœba,* &c.).
  2. Lepomonera (*Protomonas, Vampyrella, Protomyxa, Myxastrum,* &c).
- II Flagellata.
  1. Nudiflagellata (*Euglena, Spondylomorum,* &c.).
  2. Cilioflagellata (*Peridinium, Ceratium,* &c.).
- III. Labyrinthulea (*Labyrinthula*).
- IV. Diatomea (*Bacillaria*).
- V. Phycochromaceæ.
  1. Chrysococcacea (*Glœocapsa, Merismopædia,* &c.).
  2. Oscillarinea (*Nostochacea, Rivulariacea,* &c.).
- VI. Fungi.
  1. Phycomycetes (*Saprolegnieæ, Mucorineæ,* &c.).
  2. Hypodermiæ (*Uredinæ, Ustilaginæ,* &c.).
  3. Basidiomycetes (*Hymenomycetes, Gastromycetes,* &c.).
  4. Ascomycetes (*Protomycetes, Discomycetes,* &c.).
- VII. Myxomycetes (Mycetozoa).
- VIII. Protoplasta (Amœboida).
  1. Gymnamœbæ (*Autamœba,* &c.).
  2. Lepamœbæ (*Arcella, Difflugia,* &c.).
  3. Gregarinæ (*Gregarina*).
- IX. Noctilucæ. *Noctiluca.*
- X. Rhizopoda.
  1. Acyttaria (Monothalamia and Polythalamia).
  2. Heliozoa (*Actinosphærium*).
  3. Radiolaria (Monocytharia and Polycytharia).

(See PLASTIDS.)

The Monera are cytods, and never possess a nucleus; the Gymnomonera never pass into a resting condition or become invested with a cell-wall or test; but the Lepomonera, which commence life as Gymnocytodes, become invested with a cell-wall in their resting stage. Such Monera as *Protogenes* and *Protamœba* remain as single isolated cytods, and new individuals separate from the parent by fission or separation of it into two. And other Monera form a colony in a certain sense, producing the resting or encysted stage, and the invested protoplasm

resolves itself into numerous zoospores. The Flagellata resemble the zoospores of *Protomonas* and *Protomyxa*, but they have nuclei and envelopes, and the Labyrinthulea also. The colossal naked moving sarcode bodies of *Protogenes*, *Protomyxa*, and of *Vampyrella* closely resemble the plasmodia of the Myxomycetes; but their development separates the groups readily. The nucleated zoospores of the last-named organism distinguish it. With regard to the Protoplasta, Haeckel regards *Gregarinæ* as Amœbæ which have degenerated by parasitism. *Protamœba* of the Monera, however, is distinguished from Amœba by the absence of a nucleus and of the contractile vesicles. The distinction of the remaining group is decided. See Genera.

A group, the Catallacta, has been founded by Haeckel to include the genus *Magosphæra*; and its position is between the Flagellata and Protoplasta. The life-cycle of *Magosphæra* is as follows. At first it is quiescent and vegetative, and is—1. Unicellular quiescent (egg); 2. multicellular quiescent stage (cleavage). Then it takes on the active condition; 3. multicellular swarm stage; 4. unicellular ciliate stage; 5. unicellular amœboid stage.

Bibl. Haeckel, *Gener. Morphol.*; *Natürliche Schöpfung*, *Monog. der Moneren*, *Jenai. Zeit. für Med.* 6. iv. p. 1; *Biol. Studien*, p. 1; Wright and Kirby, *Qu. Mic. Jn.* 1869 & 1871.

PROTOCOC'CUS, Ag.—A genus of Volvocineæ (Confervoid Algæ), at present very imperfectly known, since without a tolerably complete history of the development of the forms it is impossible to distinguish the true species of *Protococcus* from the young states of the more complicated Palmellaceæ, and even from the germinating gonidia of the Lichens. As we have limited it, *Protococcus* includes those unicellular Algæ which in the aquatic state consist of single zoospore-like bodies, with a more or less evident gelatinous cellulose envelope through which the two cilia protrude. They move actively, and are multiplied by division during the active state. Finally they settle down into a resting-stage; and they may then increase by vegetation so as to form granular patches. Mostly, however, those which settle down turn red and acquire a thick coat, passing through a stage of rest before they germinate again, apparently requiring to be dried up first. When they germinate, they frequently produce many generations of *still* forms before the active ciliated forms reappear, especially when placed on damp surfaces, and not in water. When placed in favourable circumstances, the resting-forms (even after several years) recommence the course of vegetation, reacquiring the green colour by degrees in the course of several generations of vegetative cells. The contents of the red form appear to consist partly of oil-globules; in the green form the protoplasmic substance is coloured by chlorophyll, and at a certain stage contains starch.

We have traced *P. viridis* through all these stages, as represented in Pl. 3. fig. 2 *a–g*: a most elaborate monograph of *P. pluvialis* has been written by Cohn, which is far too extensive to be analyzed here, but goes to establish the same conclusion, that the genus *Hæmatococcus* is founded on states of *Protococcus*. The *P. viridis* of our figures is undoubtedly *Chlamidomonas*, one of Ehrenberg's genera of Polygastrica, synonymous with *Diselmis*, Dujardin. This form appears at first sight nearly allied to *Euglena*; but there are striking differences in the appearance and movements of the active forms, and the "vegetative" forms are somewhat different. It may be remarked, however, that the zoospores of *Protococcus viridis*, allowed to dry upon a slide, often turn red and look just like small *Astasiæ* (Pl. 3. fig. 2 *g*).

We have remarked under Palmella, that the Polar red snow appears to be a Palmella (Pl. 3. fig. 3 *d*), although this species has been called *Protococcus* and *Hæmatococcus nivalis*; and it appears to us that Shuttleworth and others have confounded this with *Protococcus pluvialis*. Hassall's species of *Hæmatococcus*, nos. 8 to 19, with the exception of *H. vulgaris* (*Chlorococcum*) (Pl. 3. fig. 1), are probably congeneric with our *P. viridis*. We find it impossible to extricate the British forms from their confusion; the Palmellaceæ require a thorough study in a living state. Meneghini's definitions of the genera will not hold; and Kützing has multiplied species indefinitely.

Our *P. viridis* makes its appearance commonly on damp earth, sand, &c., forming a greenish coat of no perceptible thickness; and the zoospores (*Chlamidomonas*) occur constantly in standing pools in spring and autumn, tinging the surface of the water bright green, and, as they settle to rest, forming a kind of green scum at the margins (constituting the *green matter* of Priestley). Cells of resting-form 1-2400″ in diameter. *P. pluvialis* colours water red

in like manner; it occurs on mountains, especially in melted snow-water. Cells of resting-form 1-1250 to 1-625" in diameter. Similar colorations, however, are produced by various other organisms (see WATER).

It may be observed that when the active forms of *P. viridis* and *P. pluvialis* divide without coming to rest, they produce forms which are undistinguishable from many of Ehrenberg's species of Polygastrica. When they acquire a loose cellulose coat before losing their cilia, they represent *Gyges*; at other times they resemble *Chlorogonium, Uvella, Polytoma, Monas, Bodo*, &c.

BIBL. Harvey, *Brit. Alg.* 1 ed. p. 180; Hassall, *Brit. Fr. Alg.* p. 321, &c., pls. 76–82; Meneghini, *Trans. Turin Acad.* 2 ser. v. p. 1; Cohn, *Nova Acta*, xxii. p. 605 (abstr. in *Ray Soc. Vol.* 1853, p. 514); Von Flotow, *Nova Acta*, xx. p. 414; Alex. Braun, *Verjüngung, &c.* (*Ray Soc. Vol.* 1853, p. 206 *et seq.*); Nägeli, *Einzellige Algen*, passim; Kützing, *Spec. Alg.* p. 196; *Tab. Phyc.* i. pls. 1–6; Rabenht. *Fl. Eur. Alg.* iii. p. 56. See also under RED SNOW.

PROTODER'MA, Ktz.—A genus of Ulvaceæ (Confervoid Algæ).

Char. The cells are in a thin layer, and form a membrano-crustaceous expansion; the cells are round, but somewhat angular in outline. *P. viride*, cells 1-300". Continental. Propagation unknown.

BIBL. Ktz. *Phycol. Gener.* p. 295; Rabenht. *Fl. Eur. Alg.* iii. p. 307.

PROTOG'ENES, Haeckel. A genus of Protista.

Char. A simple shapeless protoplasm-body without the formation of vacuoles, which protrudes ramifying and anastomosing processes, and reproduces itself by fission.

Species. *Protogenes primordialis*, Haeckel, "Ueber den Sarcodekörper der Rhizopoden," *l. c.* p. 360, pl. 26. figs. 1, 2. Protoplasm body sometimes contracted globularly, from 0·1–1 millim. diameter, sometimes extended and flattened out, of an irregular outline, of 3–4 millims. diameter; pseudopods exceedingly numerous (over a thousand), very fine, with very numerous ramifications and anastomoses.

Locality. Mediterranean, near Nice, 1864.

BIBL. Haeckel, *Zeitschr. für wissensch. Zool.* vol. xv. 1865, p. 360.

PROTOHY'DRA, Greef.—A genus of Cœlenterata.

Char. It has the histological characters of the freshwater Hydra; but its structure is far simpler, as it has no tentacles. Reproduction by transverse fission. Nematophores (?nematocysts) and pigment-cells are present.

BIBL. Greef, *Sieb. u. Köll. Zeit.* i. 1870; *Qu. Mic. Jn.* 1870, p. 297.

PROTOM'ONAS, Haeckel. A genus of Protista.

Char. A simple shapeless protoplasm body (without the formation of vacuoles) which protrudes simple or ramifying pseudopods. Reproduction by zoospores, which combine into plasmodia.

Species. *Protomonas amyli*, Haeckel. This form was previously described and figured by Cienkowski as *Monas amyli.* Protoplasm body a plasmodium which arises from the fusion of several zoospores, about 0·02–0·05 millim. diameter, with a few, ramifying, very fine pseudopods. Resting condition a roundish Lepocytode, whose membrane throws out wedge-shaped warts, which project inwards. Zoospores spindle-shaped, very contractile, furnished with several (two) flagella, moving themselves in the manner of an *Anguillula.*

Locality. In decaying *Nitella* from fresh water in Germany and Russia (Cienkowski).

BIBL. Haeckel, *Gen. Morph.* vol. ii. p. 23; abstract of in *Qu. Mic. Jn.* 1869.

PROTOM'YCES, Unger.—A genus of Ustilaginei (Coniomycetous Fungi), growing in the intercellular passages of leaves and leaf-stalks. According to De Bary, these Fungi consist of ramified filaments creeping between the cells of soft tissues, and swelling up at intervals (apparently where they meet an intercullular space large enough), to form globular spores: a filament with several spores in course of division appears like a varicose tube; it is septate, however; and when the globular spores are mature, they have a double coat; in *P. macrosporus* the diameter of the ripe spore is about 1-5000". When advanced in age, the mycelium appears to be wholly converted into spores, which become free. The existence of these Fungi is rendered more or less evident externally by warty projections of the epidermis, finally bursting. Unger describes four species—*P. macrosporus* occurring on *Ægopodium* and *Angelica*, *P. endogenus* (*Galii*) occurring on *Galium mollugo*, *P. microsporus* on *Ranunculus repens*, and *P. Paridis* on *Paris quadrifolia.* De Bary found a species on *Menyanthes*, with oval spores 1-800" long and 1-1300" broad.

BIBL. Unger, *Exanthem. der Pflanz.* p. 341;

De Bary, *Brandpilze*, p. 15, pls. 1 & 2; Lêveillé, *Ann. des Sc. Nat.* 3 sér. viii. p. 374; Tulasne, *ibid.* vii. p. 112; Fries, *Summa Veg.* p. 517.

PROTOMYX'A, Haeckel.—A genus of Protista.

Char. A simple shapeless protoplasm body (with the formation of vacuoles), which protrudes ramifying and anastomosing pseudopods. Reproduction by zoospores, which combine together into plasmodia.

Species. *Protomyxa aurantiaca*, Haeckel. Protoplasm body a plasmodium of orange-red colour, which (always?) originates from the fusion of several zoospores, of 0·5–1 millim. diameter, with very numerous and very thick ramifying and anastomosing pseudopods, which form a network by many anastomoses. Resting condition, a globular Lepocytode of 0·15 millim. diameter, with a thick structureless covering (cyst). Zoospores pear-shaped, produced into a very strong flagellum at the pointed cone-shaped end, at first moving in the manner of the zoospores of the Myxomyceta, and afterwards creeping along in the manner of an *Amœba.*

Locality. On empty shells of *Spirula Peronii*, floating about on the open sea, and driven in on the coast of the Canary island Lanzarote, 1867.

Bibl. Haeckel, *Gen. Morph.*

PROTOPLASM.—The name applied by Mohl to the colourless or yellowish, smooth or granular viscid substance, of nitrogenous constitution, which constitutes the formative substance in the contents of vegetable cells, in the condition of gelatinous strata, reticulated threads, and nuclear aggregations, &c. It is the same substance as that formerly termed by Dujardin Sarcode, and by the Germans "*Schleim*," which was usually translated in English works by "mucus" or "mucilage" (see Primordial Utricle, and Cell, Vegetable).

Protoplasm has received a far wider significance since the discovery of *Amœba*, and the structureless sarcode of the Rhizopoda. It is now considered to be the simplest form which organized matter can assume, and which, without any other material peculiarities except a certain softness, transparency, and jelly-like condition, is capable of contracting, expanding, and assimilating. This physical basis of life is common to the Protista and to the animal and vegetable kingdoms, and is probably composed of carbon, hydrogen, oxygen, and nitrogen. It is matter, homogeneous, so far as its examination by the highest powers of the microscope can tell, which under the influence of "life" can reproduce itself, increase in size, and move. But it is evident that as soon as any change occurs in protoplasm which determines the presence of a new structure differing in any way from it, the differentiated structure cannot retain that name. It is no longer protoplasm. The first differentiation is the nucleus; and the cell-wall follows. Of the chemical composition of nuclei nothing definite is known; but the well-known composition of cell-wall indicates that a chemical change has taken place in the protoplasm during its formation. As the true protoplasm differs chemically and physically from its derivative nucleus and cell-wall, it is to be expected that certain reagents and staining solutions will act upon it in a different manner than on them. Hence protoplasm may be readily distinguished. The nucleus of a cell is not protoplasm pure and simple, nor is a cell-wall; but it must be remembered that nuclei and cell-walls may become reabsorbed and return to matter which cannot be distinguished from protoplasm. The nucleus is in many instances an active entity in a cell; it is a germinating substance, and can multiply by fission, by breaking up into particles, and by the formation of nucleoli, which in their turn become nuclei; but in other cells it is as fixed a biological quantity as the cell-wall and the non-nitrogenous cell-contents.

In examining the growth of the minute cells of water-plants, it is impossible to do otherwise than recognize the close relation between the undifferentiated protoplasm of the cell and the delicate cell-wall; and it is as evident in them as it is in the cells of the plant-embryo in the embryo-sac, that the cell-walls are not dead and formed tissue in the sense that they cannot be reabsorbed, modified, and nourished.

The movement of protoplasm is intrinsic, and bears a relation to the absorption of organic nourishment which may be progressing. It may be the usual amœboid, creeping, rolling, sliding movement of the whole mass, with expansion and contraction of certain parts. For instance, expansion and protrusion of a portion of the surface forms a definite or indefinite point, and to a greater or less extent. Such pseudopodia may unite at their distal ends and form a network, and be retracted again, or may

remain. In this case the streaming movement of the protoplasm is common, and granules included in it and globules of protoplasm move along on the long pseudopodial threads in definite lines and turn or progress. An instance of the contractility of portions of the mass is shown when there are spaces or vacuoles seen (including probably a liquid protoplasm), which suddenly close in and return to view.

Bioplasm (Beale) is to a certain extent synonymous with protoplasm, as is also sarcode; but formed or differentiated material should be carefully separated, so far as terminology is concerned, from the structureless plasma. Hence fibrillar and granular protoplasms are miscalled; but there is no reason why structureless protoplasm should not be admitted to exist in combination with organized material. Nearly every work on physiological and comparative anatomy contains descriptions of protoplasm; and Beale sums up his views in 'How to Work,' 4th edit.

PROTOZO'A.—This term was proposed by Siebold to designate a group of invertebrate animals characterized by the absence of distinct organs, the form and simple organization being reducible to a cell.

Siebold included in it the Infusoria and the Rhizopoda, the latter consisting of the Amœbæa, Arcellina, and Foraminifera.

If the above definition be adopted, it must be remembered that the cell may be represented by the cell-contents only; and these we believe to constitute the essential part of a cell. (See edition 1856.)

Subsequent writers extended the bounds of the subkingdom, and grouped in it the classes Gregarinida, Rhizopoda, and the Infusoria, this class being composed of Suctoria, Ciliata, and Flagellata. Moreover the Spongida were classed amongst the Rhizopoda, so as to include them. The subkingdom is therefore very comprehensive, and really includes all supposed animal beings lower than the Cœlenterata. How it may be subdivided may be understood by studying PROTISTA and RHIZOPODA.

BIBL. Works on Comp. Anat.

PSALLIO'TA, Fr.—A subgenus of AGARICUS, belonging to the brown-purple spored series, characterized by the presence of a veil fixed to the stem and forming a ring. *A. campestris* and *A. arvensis* belong to this subgenus; but some of the species or, even, varieties are poisonous.

BIBL. Fr. *Ep.* p. 212; Berk. *Outl.* p. 165; Cooke, *Handb.* p. 136.

PSECA'DIUM, Reuss.—A globose or Glanduline *Marginulina*. Fossil.

BIBL. Reuss, *Sitz. Ak. Wien*, xliv. 368.

PSEUDEMBRYO.—In the development of the Echinodermata the embryonic mass of cells is converted into a peculiar zooid or pseudembryo, which gives rise to the Echinoderms by a process of internal gemmation.

BIBL. Carpenter, *The Microscope*, p. 568.

PSEUDOCH'LAMYS, Clap. et Lach.—A genus of the family Amœbina, order Proteina (Rhizopoda).

It differs from *Difflugia* and *Arcella* in having a flexible test or covering, and forms the link between the protected and unprotected amœbina. 1 species. Berlin.

BIBL. Claparède et Lachmann, *Etudes*, p. 443.

PSEUDOCYTH'ERE, G. O. Sars.—One of the *Cytheridæ*; valves very thin, obliquely quadrangular; five joints in upper, seven in lower antennæ, which are long and have long setæ; no eyes. 1 British species.

BIBL. G. S. Brady, *Tr. Linn. Soc.* xxvi. 453.

PSEUDO-DIFFLUGIA, Schlum. — A genus of Arcellina.

Char. Shell membranous, ovoid or ovoglobular, smooth or striped spirally, with a wide round opening whence come pseudopodia.

BIBL. Pritchard, *Infusoria*, p. 557.

PSEUDOGONIDIA.—A term applied to bodies appearing in the interior of cells of Algæ, which are obscure in their nature, being either metamorphosed and isolated masses of protoplasm or parasitic bodies, resembling monads. They are apparently connected with the objects called CHYTRIDIUM and PYTHIUM.

BIBL. Cienkowski, *Pringsheim's Jahrb. d. Botanik*, i. p. 371.

PSEUDOG'RAPHIS, Nyl.—A genus of Microlichens parasitic on Lecanoræ.

Char. Spores colourless or becoming brown, 4–6-locular, sometimes becoming submuriform; slightly blue with iodine.

BIBL. Lindsay, *Qu. Mic. Jn.* 1869, p. 352.

PSEUDOPODIA are processes of protoplasm which are protruded and retracted, or which are more or less constantly projecting from the bodies of many genera of Protista. They are formed of the protoplasm of the body of the animal, and do not possess any differentiated structures, and they contract, expand, diminish in size,

and project by means of the forces peculiar to this structureless matter. They may never extend far from the body, and they then form finger-shaped or irregular broad expansions, as in *Amœba*; they may project in long filiform processes of extreme tenuity, as in *Actinophrys*; or their base may be protected by a kind of ectosarc, leaving a long filament free, or passed through pores in calcareous tests, as in some Foraminifera. In some groups of the Protista the pseudopodia, after projecting from the body, interlace or become connected laterally in a film; and this is constant in some, but only occasional in other genera. Pseudopodia usually adhere to surfaces; and minute spores, monads, and other Infusoria stick on to them and soon sink within their glairy structure. Granules are observed in them occasionally, and also a curious streaming movement of the protoplasm from the body to the end and back again. They are the means of locomotion, adhesion, and prehension, and probably of respiration, in the lowest groups of living things, and are arbitrarily characteristic of the RHIZOPODA.

PSEUDOSPORES. — The apparent spores of *Uredinei* and *Tremellini*, which germinate and produce the real reproductive spores, which are then called *sporiola*.

PSICHOHOR'MIUM, Ktz.—This genus of Confervaceæ is now absorbed by Rabenhorst in CONFERVA, but it forms a kind of subgenus, and includes Confervæ whose filaments are more or less covered, girt, or incrusted with oxide of iron or carbonate of lime. Found in fresh water, and also in mineral saline waters.

BIBL. Rabenht. *Fl. Eur. Alg.* iii. p. 324.

PSILO'NIA, Fr.—A genus of Sepedoniei (Hyphomycetous Fungi), consisting of little compact tufts of twisted filaments, at first covering the fusiform, globose, or oval spores, which arise from the wart-like protuberances on the central filaments, and soon become free. They are found on dead wood or on reeds.

BIBL. Berk. *Brit. Flora*, ii. pt. 2. p. 353; *Ann. Nat. Hist.* ser. 2. viii. p. 179; Fries, *Summa Veg.* p. 495.

PSILOTEÆ.—A family of Lycopodiaceous plants, distinguished by their many-celled sporanges, varying much in habit and external appearance.

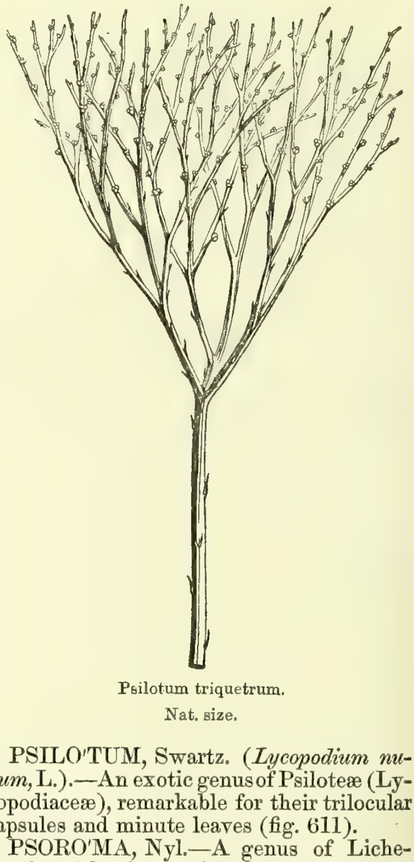
Synopsis of Genera.

1. *Psilotum.* Sporanges sessile, three-celled, bursting imperfectly into three valves by a vertical crack, filled with mealy spores.

2. *Tmesipteris.* Sporanges sessile, three-celled, bursting imperfectly into two valves by a vertical crack, filled with mealy spores.

3. *Isoëtes.* Sporanges imbedded in the bases of the leaves, and adnate at the back, not valvate, with several transverse septa; containing two kinds of spores (in distinct sporangia).

Fig. 610.



Psilotum triquetrum.
Nat. size.

PSILO'TUM, Swartz. (*Lycopodium nudum*, L.).—An exotic genus of Psiloteæ (Lycopodiaceæ), remarkable for their trilocular capsules and minute leaves (fig. 611).

PSORO'MA, Nyl.—A genus of Lichenacei, with the gonidial stratum of the thallus consisting of large distinct gonidia.

BIBL. Leighton, *Brit. Lich. Flora*, p. 163.

PSOROP'TES (Gervais).—A genus of Arachnida, of the order Acarina, and family Acarea.

Char. Body soft, depressed, with rigid hairs beneath, and on the legs.

Parasitic upon the horse (and other mammalia?).

P. equi (Pl. 2. fig. 18), itch-insect of the horse. Found upon the scaly crusts formed upon the body. Mandibles each terminated by two teeth, and not chelate; palpi three-jointed, and adherent to the labium; ventral surface covered with parallel undulating rugæ; at the end of the body are two fleshy lobes, terminated by a tuft of setæ.

BIBL. Hering, *Nov. Act. N. Cur.* xviii. 585; Gervais, *Walckenaer's Aptères,* iii. 266; Dujardin, *Obs. au Micr.* 147.

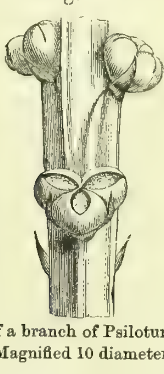
PSOROSPERMIÆ.—These bodies were discovered by J. Müller, and appear to represent the pseudo-naviculæ of the *Gregarinæ* of fishes.

They are microscopic, oval, depressed, or discoidal corpuscles, with or without a tail, exhibiting no movements, and consisting of a tolerably firm outer coat, containing one or two oblong contiguous vesicles at that end of the body opposite the tail. They are about 1-2500 to 1-2000″ in length, and are contained in immense numbers in minute cysts, in almost every part of the body of fishes, as upon the gills, in the muscles, and between the coats of the eye, in the swimming-bladder, &c. Sometimes they are imbedded in a ramified sarcodic mass.

Diameter of the cysts on the pike 1-50 to 1-25″; of the corpuscles, length 1-2000″, breadth 1-3500″.

BIBL. Müller, *Archiv,* 1841. 477, 1842. 193; Creplin, *ibid.* 1842, p. 61; Dujardin, *Helminthes,* 643; Leydig, *Müll. Archiv,* 1851. 221 (*Microsc. Journ.* 1853, i. 206); Ch. Robin, *Végét. Parasit.* 2 ed. p. 291.

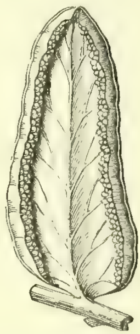
Fig. 611.



Fragment of a branch of Psilotum triquetrum. Magnified 10 diameters.

PTERIS, Linn.—A genus of Adianteæ (Polypodioid Ferns), represented by one indigenous species, *Pteris aquilina,* common Brake Fern.

Fig. 612.



Pteris.
A pinnule with marginal indusiate sori.
Magnified 10 diameters.

PTERODINA, Ehr.—A genus of Rotatoria, of the family Brachionæa.

Char. Eyes two, frontal; foot simply styliform. At the end of the tail-like foot is a suctorial disk; jaws with the teeth either arranged in a row, or two teeth only in each.

Three species; two aquatic, one marine.

P. patina (Pl. 35. fig. 20). Testula membranous, orbicular, crystalline, roughish near the broad margin; a depression present between the rotatory lobes. Aquatic; length 1-120″.

BIBL. Ehrenberg, *Infus.* p. 516; Pritchard, *Infusoria,* p. 711.

PTEROPTUS, Dufour.—A genus of Arachnida, of the order Acarina, and family Gamasea.

Char. Body depressed; last joint of palpi longest; legs stout, with short joints.

P. vespertilionis (Pl. 2. fig. 39). Found upon bats. Several species have been described; but the subject requires revision.

BIBL. Gervais, *Walckenaer's Aptères,* iii. 227; Dufour, *Ann. des Sc. Nat.* xvi. 98, xxv. 9; Koch, *Deutschlands Crustac.*

PTERYGONIUM, Sw.—A genus of Mosses. See NECKERA.

PTILIDIUM, Nees.—A genus of Jungermannieæ (Hepaticæ), containing one elegant British species, *P. ciliare,* frequent on heaths and rocks in subalpine districts, but rarely found in fruit.

BIBL. Hooker, *Brit. Flor.* ii. p. 126; *Brit. Jung.* pl. 65; Ekart, *Synops. Jung.* pl. 5. fig. 36.

PTILO'TA, Ag.—A genus of Ceramiaceæ (Florideous Algæ), with flat feathery fronds a few inches high; of a deep red colour, growing on *Laminariæ* or *Fuci*, or on rocks between tide-marks. The fructification consists of:—1. clustered roundish *favellæ* containing spores, terminating the ultimate pinnules, and surrounded by an involucre or subulate ramuli, or naked; 2. tetrahedral *tetraspores* on short pedicels fringing the pinnules. Antheridia have not been observed.

BIBL. Harvey, *Brit. Mar. Alg.* p. 159, pl. 22 A; *Phyc. Brit.* pl. 70; Greville, *Alg. Brit.* pl. 16; Nägeli, *Neuere Algensystem*, pl. 6. figs. 38–42.

PTYGU'RA, Ehr.—A genus of Rotatoria, of the family Ichthydina.

Char. Eyes none; no hairs upon the body; tail-like foot cylindrical, and simply truncate.

Teeth three in each jaw; anus situated at the end of the tail-like foot.

P. melicerta (Pl. 35. fig. 21). Body terete-clavate, turgid in front, hyaline; mouth with two little hook-like horns; cervical process single and smooth. Aquatic; length 1-144''.

Ehrenberg questions whether this is not a young form of another genus.

BIBL. Ehrenberg, *Infus.* p. 387; Pritchard, *Infus.*

PTYXID'IUM, Perty.—A genus of Euchelia. It should probably be included in LEUCOPHRYS.

BIBL. Pritchard, *Infusoria*, p. 615.

PUCCIN'IA, Persoon.—A genus of Uredinei (Coniomycetous Fungi), containing numerous parasitical species, growing upon the leaves and other herbaceous parts of the higher plants, forming "mildews" and, with their Uredinous forms, "rusts" &c. These Fungi have received considerable attention lately from Tulasne, De Bary, and others; and it appears that the genera *Uredo* and others have no distinct existence, but are preparatory forms of *Puccinia* and other genera noticed under UREDINEI. In the article ÆCIDIUM we have described the twofold reproductive structures, namely the spermogonia and the perithecia (figs. 6 & 6 *a*, p. 19; Pl. 20. figs. 1–4), producing respectively the spermatia (supposed to have the office of spermatozoids) and the spores. In *Puccinia* three forms of reproductive organs occur: first, spermogonia, analogous to those of *Æcidium*; then the forms called Uredines (chiefly of the supposed genus *Trichobasis*), producing globular unilocular bodies, shortly stalked, and with transparent walls, but with yellow or orange-coloured contents; and lastly the true *Pucciniæ*, containing bilocular spores borne on short stalks, and having a dark-brown integument. The latter present remarkable phenomena in germination, which may be best observed in those which sprout without becoming detached from the matrix, such as *P. graminis*, which however remain quiescent until the spring following their development, while *P. Glechomæ*, *Buxi*, *Dianthi*, and others germinate in the same summer. The bilocular spores have each one pore (analogous to the pores of POLLEN-grains), from which extends a filamentous process, ultimately giving rise to four short processes, each terminating in a pointed process bearing a *sporidium*, of more or less curved elliptical form. About the time when these fall off, the filament bearing the four processes becomes divided by septa into four chambers, but then appears to die. The sporidia germinate and produce a filament, which, instead of becoming the basis of a mycelium, reproduces a sporidium smaller than the first. More is said respecting these remarkable organisms under the head of UREDINEI.

The *Pucciniæ* present the following general characters:—The *spermogonia* rare, scattered on either face of the infested leaf, with an immersed, ostiolate peridiole, bearing long cilia at the mouth; pale, orange, or blackish in colour. The *Uredinous* fruits are scattered or grouped in circles, devoid of a proper peridium, but surrounded sometimes by thickish cylindrical paraphyses, very rarely connected below into a membrane, forming a kind of ciliated peridium; the *stylospores* are round and mostly spinulose, with three or four equidistant pores. The *Puccineous* fruits are also scattered or grouped in circles, sometimes containing only their proper spores, sometimes with Uredinous spores intermixed, destitute of a proper peridium, but, like the *Uredines*, having sometimes a false envelope formed of confluent paraphyses; their *spores*, forming the chief distinctive character of the genus, are *bilocular*, oblong or globose, rounded-obtuse or acuminate at the apex, smooth or spinulose, the upper loculus with a pore at its summit, the lower with a pore at the upper end of one side (next the septum).

These plants occur commonly on the Grasses and many other herbaceous plants,

often changing colour during the summer, being yellow or orange when the Uredinous spores are ripe, and afterwards blackish when the Puccineous form is mature.

The species are very numerous; but some of those formerly included under this name are now removed to other genera, such as *Uromyces*, *Triphragmium*, &c. (See UREDINEI.) *P. graminis* is common on corn and other grasses (*Mildew*); among the other frequent species are *P. Caricis*, *Polygonorum*, *Menthæ*, *Anemones*, *Buxi*, &c. Ch. Robin describes a *Puccinia*, apparently on the authority of Ardsten, a Swedish physician, found upon the human head in FAVUS. From his description it appears to be a true *Puccinia*, and should hold its place (*P. Favi*, Ardst.) among the species. But what is more remarkable, it occurs together with *Achorion Schœnleinii*, the latter presenting itself as a constituent of the cups or crusts, while the *Puccinia* occurs afterwards on the desquamations of the epidermis. This appears to warrant (from what we know of the species parasitic on vegetables) the opinion that the ACHORION is merely the spermogonial form of the *P. Favi*.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 363; *Ann. Nat. Hist.* vi. p. 439; *ibid.* 2 ser. v. p. 462, xiii. p. 461; Tulasne, *Ann. des Sc. Nat.* 3 sér. vii. p. 12; *ibid.* 4 sér. ii. p. 77, 138 & 182; Léveillé, *ibid.* 3 sér. viii. p. 369; De Bary, *Brandpilze*, p. 36; Fries, *Summa Veg.* p. 513; Robin, *Végétaux Parasit.* 2nd ed. p. 613, pl. 14. fig. 13.

PULEX, Linn. (Flea).—A genus of Insects, of the order Siphonaptera (Suctoria or Aphaniptera), and family Pulicidæ.

Char. As there are only the single family and genus in the order, the characters of the latter are distinctive.

Head small (Pl. 28. fig. 9), compressed, rounded above, truncate in front, in some species with an inferior pectinate fringe of blackish-brown teeth; eyes one on each side, round, simple, smooth; behind each eye is a cavity or depression, at the bottom of which the antennæ are attached; antennæ (figs. 9 *a*, 12) four-jointed, their form varying in the different species, the third joint very minute, and forming the cup-shaped base of the terminal joint or piece, which in some species is furnished with numerous transverse incisions, representing as many distinct joints; in some the antennæ extend out of the depression, and are carried erect.

Oral appendages (Pl. 28. fig. 9 *e*) composed of several parts: 1. (Pl. 26. figs. 32 *d* 33 *d*) The uppermost is single, and consists of a thin, flattened seta, coarsely toothed on the upper surface, and traversed throughout its entire length by a canal, upon the walls of which a very slender trachea runs, and from which very minute canals, terminating at the end of the little teeth, are given off. This is the suctorial organ, and perhaps corresponds to the labrum, but is sometimes regarded as the lingua or ligula. 2. (figs. 32 *f*, 33 *f*) Two quadrangular, narrow, and elongated plates, each furnished with longitudinal ribs, and with fine teeth; these are the lancets or scalpella, and correspond to the mandibles. 3. (Pl. 26. fig. 32 *g*) Two somewhat triangular or leaf-like plates, the maxillæ; to which are attached—4. (Pl. 26. fig. 32 *h*; Pl. 28. fig. 9 *d*) Two nearly cylindrical four-jointed maxillary palpi. 5. (Pl. 26. fig. 32 *k*; fig. 33 *k*) Two labial palpi, in the form of sheaths, four-jointed, thickened at the back and membranous at the margin; these palpi arise from near the apex of—6. (Pl. 26. fig. 33 *l*) A small membranous labium, with the still smaller mentum (Pl. 26. fig. 33 *m*) at its base.

Thorax composed of three segments, each consisting of an upper (Pl. 28. fig. 9 *c*) and a lower piece (*f f*, that of the metathoracic segment is not lettered); from the lower arise the corresponding legs. The two posterior segments of the thorax are each furnished with a pair of plates, the hindermost of which is longest, and nearly covers the sides of the first and part of the second abdominal segment (fig. 9, behind *f*, *f*); these represent rudimentary wings.

The legs are large, especially the hinder ones, and adapted for leaping. The first joint or coxa (*g*) is very thick; the second or trochanter (*h*) is very small; next come the femur (*i*), the tibia (*k*), and lastly the five-jointed tarsus (*l*), which is terminated by two curved and denticulate claws, with a lobe or heel at the base.

The abdomen of the female has nine distinct rings, the first seven of which are each furnished with a pair of stigmata (*a*), and consist of horny arches with membranous margins. The eighth arch, which has no membranous margin, is strengthened by a horny band furnished with fine hairs, to protect the orifice of the last stigma. The ninth and last segment, called the pygidium (fig. 9× and Pl. 1. fig. 13), is somewhat kidney-shaped or two-lobed, folded on the dorsum, and exhibits twenty-five to twenty-

eight stiff and longish bristles, implanted in the centre of as many disk-like areolæ, each of which is ornamented with a ring of rectangular or somewhat cuneate rays. The portions of the pygidium between the areolæ are studded with minute spines. The end of the abdomen in the female (Pl. 28. fig. 9) is more rounded or ovate than that of the male (fig. 13), which is somewhat turned upwards.

In some species the segments of the thorax and abdomen are furnished with a posterior pectinate fringe.

The alimentary canal is short and straight; the stomach cylindrical; the small intestine as long as the stomach, and the large intestine short. Four short and broad Malpighian vessels open into the lower orifice of the stomach; and the ducts of two round salivary vesicles unite to a single canal ascending in a coiled form on each side of the œsophagus towards the mouth.

The eggs of the flea are white, elongated and viscid outside. The larvæ have no legs; they are elongated, resembling minute worms, and very active, coiling themselves into a circle or spiral, and serpentine in their movements. The head is scaly, without eyes, and supporting two very minute antennæ; the body has thirteen segments, with small tufts of hairs, and at the end of the last are two little hooks.

The species are numerous (twenty-five, Gervais); but their characters are not well defined. One species (*P. terrestris*) is said to exist under brush-wood; and one (*P. Boleti*) in *Boleti*.

1. *P. irritans*, human flea. Pitch-brown; head shining, smooth, pectinate fringe absent; legs pale; femora of posterior legs with hairs inside; second joint of the tarsi of the anterior pair of legs and first joint of posterior tarsi longest. Tarsal joints, in respective order of greatest length: anterior, 2, 5, 1, 3, 4; posterior, 1, 5, 2, 3, 4 (Bouché). We have never been able to find a flea with the above relative length of the joints of the anterior tarsi.

2. *P. felis*, cat's flea (*P. canis*, Bouché; *P. irritans*, Dugès) (Pl. 28. fig. 9). Pale pitch-brown; head naked, shining, smooth, with delicate scattered dots; coxæ and femora almost naked; fifth joint of anterior tarsi and first joint of posterior tarsi longest. Tarsal joints: anterior, 5, 2, 1, 3, 4; posterior, 1, 2, 5, 3, 4.

3. *P. canis*, flea of dog and fox (Pl. 28. fig. 10, head) (*P. felis*, Bouché). Pale pitch-brown; head shining, smooth, punctate behind; lower part of head and prothorax with a pectinate fringe; posterior tibiæ much expanded at the end; fifth joint of anterior and first of posterior tarsi longest. Tarsi: anterior, 5, 2, 1, 3, 4; posterior, 1, 5, 2, 3, 4.

4. *P. gallinæ*, fowl's flea. Pitch-brown, with shining, smooth, elongated head: prothorax with a pectinate fringe; first joint of all the tarsi longest. Tarsi: anterior and posterior, 1, 2, 5, 3, 4.

5. *P. martis*, flea of the marten and dog. Postero-inferior margin of head and prothorax with pectinate fringe; tarsi as in *P. canis.*

6. *P. sciurorum*, flea of the squirrel. Head naked; pectinate fringe on prothorax, none upon the abdomen. Tarsi: anterior, 1, 5, 2, 3, 4; posterior, 1, 2, 5, 3, 4.

7. *P. erinacei*, flea of hedgehog. Head naked, mesothorax with a fringe. Tarsi: anterior, 5, 2, 1, 3, 4; posterior, 1, 2, 5, 3, 4.

8. *P. talpæ*, Curtis, flea of mole (Pl. 28. fig. 24).

9. *P. columbæ*, pigeon's flea. Prothorax with pectinate fringe, none upon the abdomen; antennæ of male erect, those of the female lying in the depression.

10. *P. penetrans*, the chigoe or jigger. The females burrow in the skin of the feet; and the ova, undergoing development, enlarge the parent-abdomen to the size of a pea, causing severe inflammation, &c. Rostrum very long. Tropical.

11. *P. vespertilionis*, flea of the bat (Pl. 28. fig. 11, head).

Bibl. Westwood, *Introduction, &c.*, ii. 489; Bouché, *Nov. Act. Nat. Cur.* 1835. xvii. 501; Dugès, *Ann. des Sc. Nat.* 1832, xxvii. p. 165; Gervais, *Walckenaer's Apt.* iii. 362; Denny, *Ann. Nat. Hist.* 1843, xii. 315; Landois, *Anat. d. Hunde-Flohs.* 1867; Furlong, *Mo. Mic. Jn.* 1872, p. 263.

PULLE'NIA, Parker & Jones.—A minute, globose, glassy, nautiloid Foraminifer, near *Globigerina*; showing usually 4 or 5 chambers, and a transverse slit-like aperture; an isomorph of *Nonionina.* Recent and fossil.

Bibl. Carpenter, *Introd. For.* 184.

PULVINULI'NA, Parker & Jones.—One of the typical *Rotalinæ.* Shell with 7–30 cells; dense and delicately tubuliferous, often limbate, sometimes prickly, granulate, and stellate; usually biconvex (*P. repanda*, Pl. 18. fig. 16); sometimes outspread, and vermiculate (*P. vermicularis*, Pl. 47. fig. 11);

septa single, little trace of canal-system; aperture large, arched or notched; septal face often coarsely perforated. Very numerous species, recent and fossil.

Bibl. Carpenter, *Introd. For.* 310; Parker and Jones, *Phil. Trans.* clv. 390.

PUNCTA'RIA, Greville.—A genus of Punctariaceæ (Fucoid Algæ), containing three (one doubtful) British species, *P. latifolia, plantaginea* and *tenuissima*, growing on rocks and stones, consisting of membranous, olive or brown, ribless fronds, 4 to 12″ long, 1 to 3″ broad, having a shield-like organ of attachment at the base. The fructification consists of *sori* scattered all over the fronds in minute distinct dots, composed of roundish sporanges (producing zoospores) intermixed with paraphyses; these sporanges are called *spores* in most works. No other form of fructification has yet been observed.

Bibl. Harvey, *Brit. Mar. Alg.* p. 41, pl. 8 B; *Phyc. Brit.* pls. 8, 128, 148; Greville, *Alg. Brit.* pl. 9.

PUNCTARIACEÆ.—A family of Fucoideæ. Root a minute naked disk; frond cylindrical, or flat, unbranched, cellular, with ovate *sporanges* intermixed with jointed threads in groups on the surface.

Synopsis of the British Genera.

1. *Punctaria.* Frond flat and leaf-like. *Sporanges* scattered or in sori.

2. *Asperococcus.* Frond membranous, tubular, either cylindrical or compressed. *Sporanges* in dot-like sori.

3. *Litosiphon.* Frond cartilaginous, filiform, subsolid. *Sporanges* scattered, almost solitary.

PUS.—Popularly known as "matter." One of the products of inflammatory exudation.

Its general properties are too well known to require description. Pus consists of an albuminous liquid, containing a number of minute corpuscles in suspension. These consist of molecules and granules composed of proteine-compounds, fat or the earthy phosphates, globules of fat of very various sizes, and the proper pus-corpuscles. Pus-corpuscles (Pl. 30. fig. 4) are spherical, from 1-2500 to 1-3500″ in diameter; presenting a granular appearance on the surface, and containiug a number of larger or smaller granules and a small quantity of liquid. They are indistinguishable from the white corpuscles of the blood, and may be considered as *leucocytes.* They possess as protoplasmic masses the power of spontaneous movement; and migrate in the tissues. They multiply by division. When treated with acetic acid, they swell up, and the granules become excessively transparent, and ultimately vanish (Pl. 30. fig. 5), leaving from one to five, generally two or three, round or oval nuclei, which mostly present a dark margin and light centre, giving them a cupped appearance, indicating a diminution of refractive power in the centre, arising from either a depression on the surface or the existence of a vacuole. The cupped centre is sometimes seen in the nuclei without acetic acid, after the action of water only.

In the pus of chronic abscesses, unhealthy ulcers, &c. the corpuscles are often few, deformed and mixed with numerous granules of proteine, fatty and calcareous matters, crystals of cholesterine, of the ammonio-phosphate of magnesia, and sometimes monads and vibrios; exudation-corpuscles are occasionally present also.

Pyoid corpuscles. — Under this term Lebert describes a modification of pus-corpuscles, consisting of a tolerably transparent envelope, enclosing from eight to ten or more small globules (Pl. 30. fig. 6). Acetic acid does not alter them, or at most only renders them slightly more transparent. The small globules are composed of a proteine-compound; for they are soluble in potash.

Bibl. That of Chemistry, Animal; and Lebert, *Phys. Pathologique*; Rindfleisch, *Path. Hist.*; Green, *Path. and Morb. Anat.* See Inflammation.

PUSTULIPORA, Blainville.—A genus of Infundibulate Cyclostomatous Polyzoa, of the family Tubuliporidæ.

Char. Polypidom erect, cylindrical; cells half-immersed, arranged on all sides; orifices prominent.

Two British species—*P. proboscidea*, and *P. deflexa.* The latter common on shells from deep water.

Bibl. Johnston, *Brit. Zooph.* 278; Gosse, *Mar. Zool.* ii. 8.

PYCNIDIA.—A term applied by Tulasne to the receptacles enclosing *stylospores* in the Lichens and Fungi.

PYCNOGONUM.—A genus of Podosomata, Sea Spiders, which are usually placed amongst the Crustacea, but by some authors amongst the Arachnida. They have no special respiratory organs, and only four pairs of legs. They sprawl over seaweed, and hide under stones. There is a pair of chelate mandibles.

PYCNOPHY'CUS, Kütz.—A genus of Fucaceæ (Fucoid Algæ), containing one British species, *P.* (FUCUS) *tuberculatus*, removed from *Fucus* on account of its cylindrical frond, the compact cellular substance of the receptacles, and the ramified fibrous pseudo-root. The fructifications, formed at the ends of the dichotomous lobes of the frond, are of elongated form, cylindrical, more or less tuberculated, and exhibit numerous pores opening from conceptacles containing *spore-sacs* and *antheridia* (together), resembling in general those of *Fucus*. The spore-sacs are collected at the bottom of the conceptacles, the antheridia at the upper part. For the details respecting the spores and spermatozoids, see FUCUS.

BIBL. Harvey, *Brit. Mar. Alg.* p. 18, pl. 2 A; *Phyc. Brit.* p. 89; Decaisne and Thuret, *Ann. des Sc. Nat.* 3 sér. iii. p. 5, &c., pl. 1; Thuret, *ibid.* xvi. p. 10.

PYCNOTHE'LIA, Ach.—A subgenus of Cladoniei.

Char. Thallus crustaceous; podetia clavate, papillæform, simple or branched, glabrous; apothecia fuscous.

BIBL. Leighton, *Brit. Lich. Flora*, p. 55.

PYOID CORPUSCLES. See PUS.

PYRAMID'IUM, Bridel.—A genus of Funariaceæ (Acrocarpous Mosses), allied to *Funaria* in habit, but differing in important points.

Pyramidium tetragonum, Brid. = *Gymnostomum tetragonum*, Schwägr.

PYRENID'IUM, Nyl.—A genus of the form Collemacei (Lichens).

Char. Thallus minute, stellato-divided; apothecia pyrenocarpous, verrucarioid. 1 species, *P. actinellum.* On chalk. Kent. Rare.

BIBL. Leighton, *Brit. Lich. Flora*, p. 36.

PYRENODEI.—A series of Lichenacei.

Char. Fructification in closed receptacles.

BIBL. Leighton, *Brit. Lich. Flora*, p. 2.

PYRENOMYCE'TES.—That portion of the Ascomycetous and Coniomycetous Fungi having a closed, nuclear fruit; standing opposed to the Discomycetes, with open fruits, like the Angiocarpous and Gymnocarpous Lichens.

PYRENOP'SIS, Nyl.—A genus of the fam. Collemacei (Lichens).

Char. Thallus granulato-areolate, granular gonima in globular cells; apothecia urceolato-innate; spores simple.

BIBL. Leighton, *Brit. Lich. Flora*, p. 14.

PYRENO'THEA, Fries.—A genus of Limborieæ (Angiocarpous Lichens), containing a number of species separated from *Verrucaria*, Ach., on account of the spores being free in the perithecia and not developed in thecæ. The bodies taken for spores, however, are spermatia contained in spermogonia, the sporiferous perithecia being apparently unknown (see LICHENS).

BIBL. Leighton, *Brit. Ang. Lichens*, p. 65; Tulasne, *Ann. des Sc. Nat.* 3 sér. xvii. p. 217.

PYRULI'NA, D'Orb.—A neat acuto-pyriform *Polymorphina.* Fossil in the Chalk, and German Tertiaries.

BIBL. D'Orbigny, *Mém. Soc. Géol. Fr.* iv. 43; Brady, Parker and Jones, *Tr. Linn. Soc.* xxvii. 219.

PYTHIUM, Pringsheim.—A supposed genus of parasitic Unicellular Algæ, the true nature of which, however, is yet doubtful.

P. entophytum (Pl. 45. fig. 8) occurs in this country in diseased cells of Confervoid Algæ. It consists of minute flask-shaped bodies, taking the place of the proper cell-contents, finally pushing the neck-like portion through the wall of the cells, outside of which it bursts and discharges active (?) molecules, which Pringsheim regards as gonidia. *P. monospermum* grows upon insects in water, in the manner of *Achlya*; and he refers this genus to the family Saprolegnieæ.

BIBL. Pringsheim, *Jahrb. d. wiss. Bot.* i. p. 289; Carter, *Ann. Nat. Hist.* 2 ser. xvii. p. 101; Henfrey, *Trans. Mic. Soc.* New Series, vii. p. 25: Currey, *Mic. Journal*, v. p. 211; Rabenht. *Fl. Eur. Alg.* iii. p. 276.

PYXIDIC'ULA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, free or sessile; valves circular, convex, hoop absent.

Numerous species have been described—one aquatic, one marine, the remainder fossil, found in America.

Rabenhorst reduces the species to *P. major*, *adriatica*, and a doubtful form, *P. Naegelii.*

1. *P. major* (Pl. 19. fig. 13). Valves conical, regularly punctate. Diameter 1-420″; aquatic.

2. *P. adriatica.* Fr. sessile; valves nearly hemispherical, free from markings (ord. ill.). Upon marine Algæ. Diam. 1-600″.

3. *P. minor* = *Cyclotella operculata.*

The bodies represented in Pl. 19. fig. 12, found in flint, have been described as *P. globator*, Pritch. (not *P. globosus*, Ehr.); they do not, however, appear to belong to the Diatomaceæ.

Kützing places *Stephanopyxis* and *Xanthiopyxis* here.

Bibl. Ehr. *Infus.* 165, and *Ber. d. Berl. Akad.* 1844 & 1845; Kütz. *Bacill.* 51, and *Spec. Alg.* xxi.; Pritchard, *Infus.* 432.

PYXILLA, Grev.—A genus of Diatomaceæ.

Bibl. Grev. *Mic. Trans.* 1865, p. 2.

PYXINEÆ.—A family of Gymnocarpous Lichens, characterized by a horizontal foliaceous thallus, mostly fixed by the centre, an orbicular disk, with the excipulum distinct from the thallus, closed at first and superficial.

It forms a part of the Phyllodei; and the Tribe Gyrophorei includes the only genus, Umbilicaria.

See Leighton, *Brit. Lich. Flora*, p. 3.

Q.

QUILL.—The quill of feathers possesses considerable polarizing power; the coloured bands, however, are so broad that they are better seen with the naked eye.

See Feathers.

QUININE. See Alkaloids.

Iodo-disulphate, sulphate of iodo-quinine, Herapathite.—This salt is prepared by dissolving disulphate of quinine in strong acetic acid, warming the solution, dropping into it an alcoholic solution of iodine carefully in small quantities at a time, and placing the mixture aside for some hours, when the crystals separate.

They dissolve in the heated mother-liquor, also in hot alcohol, being again deposited on cooling; but they are not soluble in cold alcohol or ether.

They are so easily decomposed and altered, that they are with difficulty mounted. This may, however, be effected by cautiously neutralizing the excess of acid in the mother-liquor by solution of ammonia, taking care not to precipitate the excess of the disulphate of quinine; a portion of the liquid containing the crystals is then transferred to a slide, the liquid removed with blotting-paper, and the crystals dried in a current of cold air. They are then mounted in Canada balsam rendered thin with ether, heat being avoided.

The crystals are of a pale olive-green colour (Pl. 7. fig. 17), and possess a more intense polarizing power than any other known substance. The play of colours presented when they are rolling over each other whilst contained in a watch-glass, forms a very beautiful sight, the colours varying according to the relative positions of the crystals to each other; and when the latter cross each other at a right angle, complete blackness is produced.

Dr. Herapath, who discovered this beautiful salt, has also described a method of making crystals of sufficient size to replace tourmalines or Nicol's prisms. The ingredients are:—as pure disulphate of quinine as can be obtained, that from Messrs. Howard and Kent being best; strong acetic acid, of sp. gr. 1·042; proof spirit composed of equal bulks of rectified spirit of sp. gr. ·837 and distilled water; and tincture of iodine, made by dissolving 40 grains of iodine in 1 oz. of rectified spirit. The proportions are:

Disulphate of quinine . .	50 grains.
Acetic acid	2 fluid ounces.
Proof spirit	2 fluid ounces.
Tincture of iodine	50 drops.

The disulphate of quinine is dissolved in the acetic acid mixed with the spirit, the solution heated to 130° F., and the tincture of iodine immediately added in drops, the mixture being constantly agitated.

The compound should be prepared in a wide-mouthed Florence flask or matrass; and the temperature should be maintained for a little time after the addition of the iodine, so that the solution may become perfectly clear, and of a dark sherry-colour. It should then be set aside to crystallize in a room of a uniform temperature of 45° to 50° F., and kept from vibration. The latter may be effected by suspending the flask by the neck with strong string, attaching this to a horizontal cord stretching across the room from one wall to the other; or placing the flask on a steady support, lying upon a pillow. The large crystalline plates form upon the surface of the liquid, where they are allowed to remain for twelve to twenty-four hours, until they have acquired sufficient thickness. The flask is then carefully removed without shaking, and rested upon a gallipot. A circular cover is then fastened by its edge to the end of a glass rod with a little wax or marine glue, and passed beneath one of the crystalline films, the adherent mother-liquor removed with blotting-paper, and the film allowed to dry in a room at a temperature of 45° to 50° F. The cover and film are then placed under a cupping-glass or small bell-glass, with a watch-glass containing a few drops of tincture of iodine. The time required for the iodizing may be about three hours at 50° F., or less if the temperature be higher.

The film is then covered with a solution of Canada balsam in ether, saturated with iodine by warming with a few crystals of this substance, and allowing it to cool.

Other films are removed and mounted in the same manner. Should the films not separate from the original liquid at the end of six hours, this must be heated with a spirit-lamp until the deposited crystals are dissolved, a little spirit and a few drops more tincture of iodine added, and the liquid again set aside.

If the film appear black when removed on the cover, it is crossed by an adherent or interposed crystal, which must be carefully removed.

These crystals are sold ready mounted, and may be purchased at a very small cost.

Dr. Herapath proposes the production of the crystals of the quinine-salt as a very delicate test for the presence of quinine. A test-liquid is first made with 3 drachms of acetic acid, 1 drachm of rectified spirit, and 6 drops of dilute sulphuric acid. A drop of this is placed upon a slide and the alkaloid added, and, when it is dissolved, a very minute quantity of tincture of iodine added; after a time the salt separates in little rosettes.

Bibl. Herapath, *Phil. Mag.* 1852, iii. 161, iv. 186, and 1853, vi. 171 & 346; Haidinger, *ibid.* 1853, vi. 284.

QUINQUELOCULI'NA, D'Orb.—One of the modifications of *Miliola*, having its chambers aggregated on two opposing faces, as in *Spiroloculina*, but with their edges more extended on the one side than on the other, so that only three chambers are apparent on one side, and *five* on the other. Numerous *Quinqueloculinæ* occur recent and fossil. *Q. seminulum* (Pl. 18. fig. 5) is common in the European seas. *Q. Brongniartii* (fig. 6), having delicate striæ, is not uncommon in warmer seas.

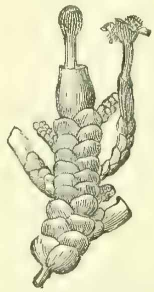
Bibl. Williamson, *Rec. Foram.* 85 (*Miliolina*); Carpenter, *Introd. For.* 78.

R.

RADIOLA'RIA, Müller.—An order of the Rhizopoda, which includes the Polycystina, Acanthometrina, and Thalassicollida, and according to Carpenter the Actinophryina also. They are Rhizopoda which possess a siliceous test or siliceous spicules, a central capsule and peculiar yellow cells, and are provided with long, protruding, radiating pseudopodia which occasionally form meshes. See the genera and Rhizopoda for Bibl., and Cienkowski, *Archiv f. Mik. Anat.* vii. 1871; *Qu. Mic. Jn.* 1871, p. 396; Focke, *Qu. Mic. Jn.* 1869; Carpenter, *The Microscope.*

RAD'ULA, Dumort.—A genus of Jungermannieæ (Hepaticæ), containing one British species, *R. complanata* (fig. 613), common upon the trunks of trees, everywhere, forming orbicular pale-green patches closely appressed to the bark.

Fig. 613.



Radula complanata.
Leafy shoot with an immature and a burst capsule.
Magnified 5 diameters.

Bibl. Hook. *Brit. Jung.* pl. 81; *Brit. Flor.* ii. pt. 1. p. 120; Ekart, *Syn. Jung.* pl. 4. fig. 31; Endlicher, *Gen. Plant*, Supp. 1. No. 472. 13.

RAD'ULUM.—A genus of Hydnei (Hymenomycetous Fungi), consisting of a few species with irregular compressed teeth or rude irregular tubercles. *R. orbiculare* is not infrequent on fallen branches of birch and other trees, assuming various forms.

Bibl. Fr. *El.* p. 148; Berk. *Outl.* p. 263; Cooke, *Handb.* p. 304.

RALF'SIA, Berk.—A genus of Myrionemaceæ (Fucoid Algæ), containing one British species, *R. verrucosa* (*R. deusta*, Berk.), forming dark-brown Lichen-like patches, 1 to 6″ in diameter, on rocks between tide-marks. The fronds are at first orbicular and concentrically zoned; they are composed of densely packed, vertical, simple, jointed filaments. The fruit is formed in wart-like patches, and consists of obovate sporanges attached to the bases of vertical filaments.

Bibl. Harvey, *Brit. Mar. Alg.* p. 49, pl. 10 D.

RAMALI'NA, Ach.—A genus of Parmeliaceæ (Gymnocarpous Lichens), containing several British species, forms of shrubby habit, mostly growing upon the trunks of

trees, bearing orbicular-peltate apothecia, nearly of the same colour as the thallus. *R. fraxinea, fastigiata,* and *farinacea* are common.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 228; Tulasne, *Ann. des Sc. Nat.* 3 sér. xvii. p. 192, pl. 2. figs. 13–15.

RA'NA, Linn. See Frog.

RAPH'IDES.—This name was first applied to the minute needle-shaped crystals occurring in great abundance in the tissues of many plants; but it is now used in general application (and according to Gulliver wrongly) to all the crystalline formations contained in vegetable cells. The crystals occur either solitary or grouped; and sometimes the groups are formed on a peculiar stalked matrix projecting into the cavity of enlarged cells, forming the organs called *cystoliths.*

There are few plants of the higher classes which do not contain raphides: they are very abundant in the herbaceous structures of the Monocotyledons generally, and especially those of the Araceæ, Musaceæ, Liliaceæ, &c.; they also abound in the Polygonaceæ, Cactaceæ, Euphorbiaceæ, Urticaceæ, &c., among the Dicotyledons. They are usually found only in the interior of the cavities of cells, but in some cases they occur in the intercellular cavities. They may occur in almost any part, but are found most extensively in the stems of herbaceous plants (Monocotyledons in general and Cactaceæ); they also occur in the bark and pith of many woody plants (lime, vine); leaves likewise frequently contain them in vast quantity (Araceæ, Musaceæ, Liliaceæ, Iridaceæ, Polygonaceæ); also sepals (Orchidaceæ, Geraniaceæ); in the rhubarbs, and also in Umbelliferæ, they occur extensively in the roots, for instance in the carrot: and they abound in autumn in the base of the bulbs of the onion and other Liliaceæ. Raphides are very readily discovered and clearly seen in tissues, by the aid of the polarizing apparatus.

The form of the needle-shaped raphides is usually that of a square prism with pyramidal ends. These ordinarily occur lying parallel in bundles (fig. 614); another common form is that of rectangular or rhombic prisms with oblique or pyramidal ends; the smaller of these often present themselves in groups radiating from a centre (fig. 615). A distinction has been made by Gulliver between raphides, Sphæraphides, and crystal prisms, such as abound in the order Iridaceæ. These last are of large size, and the shafts and tips are prismatic or angular, and they polarize light; they are not furnished with rounded shafts after the manner of the loose bundles of raphides. Crystal prisms of similar or of six-sided forms, octahedra, rhombs, &c. also occur solitary or few together (Pl. 39. fig. 28), the larger ones sometimes nearly filling the cavity of the cells in which they lie. Rhombic crystals of calcium oxalate occur in the parenchymatous cells surrounding the vascular bundles in the bracts of *Medicago trigonella*; and Gulliver has shown the crystal in each cell of the testa of the elm. The cells containing the bundles of acicular raphides in the Araceæ also contain a viscid sap, which causes them to burst, through endosmose, when placed in water, and discharge the crystals. Turpin erroneously described these as organs of a special nature, under the name of *Biforines.*

Raphides most frequently consist of oxalate of lime, especially in the Cactaceæ, Polygonaceæ, &c.; carbonate of lime seems to stand next in the order of frequency, then

Fig. 614.

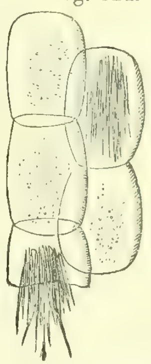


Fig. 615.

Fig. 614. Parenchymatous cells of the stem of Rumex, containing bundles of raphides. Magnified 400 diams.

Fig. 615. Parenchymatous cells of the stem of Beta, with groups of raphides (Sphæraphides). Magnified 400 diams.

sulphate and phosphate of lime. Their composition may be ascertained by the appropriate tests for these salts. It is sometimes difficult to determine the form accurately, on account of the small size; it is found advantageous to mount well-cleaned and partly crushed crystals in Canada balsam, also to view them rolling over in alcohol.

The peculiar crystalline structures called

by Weddell *cystoliths*, occur most abundantly in the families of the Urticaceæ (including Moreæ) and the Acanthaceæ. They ordinarily consist of a stalked, clavate, and globose, or irregular linear body, suspended in a greatly enlarged cell, most frequently situated beneath the epidermis of the leaf (Pl. 39. figs. 26, 27); but they also occur in deeper-seated regions. Their nature and development have been followed by several observers; and they are found to consist of a cellulose matrix with carbonate of lime crystallized in a kind of efflorescence upon the surface. They appear to originate by a little papilla or column of secondary deposit at the upper end of the cell, which increases by successive concentric layers of cellulose applied on the lower surface, leaving a short stalk-like portion which remains uncovered and also free from the crystals which gradually sprout out from the thickened head. The crystals may be removed by the action of acid; and then the matrix assumes a blue colour with sulphuric acid and iodine. Payen imagined the thicker portion incrusted by the crystals to be composed of numerous cellules, each producing a crystal: this is erroneous. The *cystoliths* vary in form; the clavate kinds may be best observed in *Ficus elastica* (Pl. 39. fig. 27) and other species, in vertical sections of the leaf; globular forms are found in *Parietaria officinalis* (fig. 26) and the Hop; in species of *Pilea* they are linear or crescentic, and suspended by the convex edge.

Thiselton Dyer believes that, in some instances, crystals are formed within the cell-wall itself; but he quotes Dr. Pfitzer, who points out that the crystals of *cytrus* originate free from any attachment, and subsequently they receive a coating of cellulose, and that ultimately the cell-wall comes into contact with them. Gulliver has shown that many genera of plants may be distinguished by their raphides and other crystals.

Bibl. Lindley (and E. Quekett), *Introd. to Botany*, 4th ed. i. p. 97; Turpin, *Ann. des Sc. Nat.* 2 sér. vi. p. 5; Raspail, *Chimie organique*; Schleiden, *Grundzüge*, 3rd ed. pp. 168, 341; *Principles*, pp. 6, 122; T. Dyer, *Qu. Mic. Jn.* 1872, p. 288; Quekett, *Trans. Mic. Soc.* new ser. i. p. 20; Gulliver, *Sci. Gossip*, 1873; *Pop. Sci. Rev.* 1865; *Ann. Nat. Hist.* 1865; *Qu. Mic. Jn.* 1866, 1869, 1873; R. Lankester, *Q. M. J.* 1863, p. 243; Urban, *Bot. Zeit.* 1873, p. 266; Wonfor, *Mo. Mic. Jn.* July 1874, p. 54.

RAPHIDIOPH'RYS, Archer.—A genus of Rhizopoda (freshwater).

Char. Numerous green spherical bodies surrounded by a common investment of cloudy buff-coloured sarcode, in which are spicula, slender, hyaline, circular, and siliceous. Pseudopodia come from the sarcode between the spicula, and are long, straight, and very thin; they never coalesce.

Bibl. Archer, *Freshwater Rhizopoda*, *Qu. Mic. Jn.* 1869, 1871.

RAPHID'IUM, Ktz.—A genus of Unicellular Algæ, family Palmellaceæ. This genus, whose species have a fusiform or cylindrical acuminate, and straight or slightly curved cell, with a delicate nonsiliceous cell-wall and green cell-contents, has been determined by Rabenhorst to include species of *Ankistrodesmus, Closterium, Micrasterias*, and *Scenedesmus*.

Bibl. Rabenht. *Fl. Eur. Alg.* iii. p. 44.

RAPHIG'NATHUS, Dugès.—A genus of Arachnida, of the order Acarina, and family Trombidina.

Char. Palpi with an indistinct claw; mandibles represented by two short setæ inserted upon a fleshy bulb, concealed by a broad labium; body entire; coxæ contiguous; legs but little attenuated at the ends, anterior longest, last joint longer than the others.

1. *R. ruberrimus* (Pl. 2. fig. 35 *a*, labium with mandibles and a palp; *b*, a mandible). Body oval, slightly depressed, smooth, and almost free from hairs, rostrum forming a conical process; eyes two, dark red, one on each side at the anterior part of the body; labium triangular, concave; setæ accompanied by a more slender hair-like process; palpi large, inflated, claw of the 4th joint very short. Size minute! Found under stones and on plants.

2. *R. hispidus*. Form, that of the preceding; body velvety, with two posterior papillæ.

Bibl. Dugès, *Ann. des Sc. Nat.* 2 sér. i. 22, ii. 55; Gervais, *Walckenaer's Aptèr.* iii. 172.

RAT'TULUS, Lamarck.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes two, frontal; tail-like foot simply styliform; neither cirri nor fins present. Teeth indistinct.

R. lunaris (Pl. 35. fig. 22). Eyes distant from the anterior margin; foot decurved, lunate. Aquatic; length 1-288″.

Bibl. Ehrenberg, *Infus.* p. 448; Pritchard, *Infusoria*, p. 688.

REAGENTS. See Introduction,

PREPARATION, PRESERVATION, and STAINING.

REBOUIL'LIA, Raddi. — A genus of Marchantieæ (Hepaticæ), founded on the *Marchantia hemisphærica*, Linn., characterized by the conical or flattened, 1–5-lobed stalked receptacle (fig. 616), the perigone being adherent to the lobes of the

Fig. 616.

Fig. 617.

Rebouillia hemisphærica.
Female receptacles, with the perigone burst.
Fig. 616, seen from above; fig. 617, from below.
Magnified 2 diameters.

receptacle on the under side, opening by a slit (fig. 617); perichæte none, and the globose sporange bursting irregularly. The antheridia are imbedded in sessile, crescent-shaped disks. The fronds are rigid, with a well-marked midrib, green above, purple beneath. It grows on moist banks, or by the side of mountain-streams.

BIBL. Hook. *Brit. Flor.* ii. pt. 1. p. 108; G. W. Bischoff, *Nova Acta*, xvii. p. 1001, pl. 69. fig. 1; Endlich. *Gen. Plant.* No. 468.

RECEPTACLES FOR SECRETIONS. See SECRETING ORGANS of Plants.

RED SNOW.—The remarkable phenomenon known under this name has been the subject of very extensive investigation, and it is well known to be the result of the enormous development of a microscopic organism related to *Protococcus* or *Chlamidococcus viridis*. We are inclined to believe that more than one form is comprehended at present under the name of *Protococcus* or *Hæmatococcus nivalis*; for our specimens of Arctic red snow (for which we are indebted to the kindness of Mr. R. Brown) appear to belong to the same genus as *Palmella cruenta*, as first indicated by Mr. Brown, and confirmed by Sir W. J. Hooker. Dr. Greville's figures of the Scotch plant closely resemble this; but the continental plants described by Mr. Shuttleworth and others would seem congeneric with *Protococcus* (*Chlamidococcus*, Braun, *Chlamidomonas*, Ehr.), since they produce active zoospores, the forms which Shuttleworth described as distinct infusoria, as species of *Astasia*. Nearly connected with this continental snow-plant, if not identical, is the *Protococcus pluvialis*, described so elaborately by Dr. Cohn, which moreover appears to be synonymous with the *Discercæa purpurea* of Morren.

The following is a description of the red snow (brought home by Capt. Parry) from our own observation. It may be noticed as remarkable that, after being kept so many years in a moist state in a stoppered bottle, the structure appears almost unchanged, the only difference being the assumption of a green colour on the surface of the masses when exposed to light. Frond an indefinite gelatinous mass densely filled with spherical cells, about 1-1200″ in diameter (Pl. 3. fig. 3 *d*); cells with a distinct membrane, their contents consisting of numerous tolerably equal granules, red or green (see above). Between the large cells lie patches of minute red granules (as in *Palmellu cruenta*, Pl. 3. fig. 3 *a*, *b*), apparently discharged from the large cells. Bauer and Greville both describe this as the mode of propagation of the plant; but it is probable that the cells also increase by division when actively vegetating.

BIBL. R. Brown, *Appendix to Ross's First Voyage*, London, 1819; DeCandolle, *Bibl. univ. de Genève*, 1824; Hooker, *Append. to Parry's Second Voyage*; Greville, *Sc. Crypt. Fl.* pl. 231; Shuttleworth, *Bibl. univ. de Genève*, Feb. 1840; Morren, *Hydrophytes de Belgique*, *Mém. Acad. Bruxelles*, xiv. 1841; Von Flotow, *Nova Acta*, xx. p. 11; Cohn, *Nova Acta*, xxii. p. 605; Carpenter, *The Microscope*.

RED SPIDER.—The insect so called by gardeners is a GAMASUS.

RENULI'NA, Lamarck.—A short, broad, reniform modification of *Vertebralina*, one of the porcellaneous Foraminifera.

BIBL. Carpenter, *Introd. For.* 74.

RESERVOIRS FOR SECRETIONS IN PLANTS. See SECRETING ORGANS of Plants.

RETE MUCOSUM. See SKIN.

RETEP'ORA, Lamk.—A genus of Infundibulate Cheilostomatous Polyzoa, of the family Escharidæ.

Char. Polypidom leafy, reticular, fragile; cells on one surface only, short, and not prominent. Two British species:

1. *R. reticulata.* Wavy and convolute, upper side warty and very porous.

2. *R. beaniana.* Umbilicate, funnel-shaped, wavy; interspaces unarmed.

BIBL. Johnston, *Brit. Zooph.* 353; Gosse, *Mar. Zool.* 18.

RETICULA'RIA, Bull.—A genus of Myxogastres (Gasteromycetous Fungi), characterized by the indeterminate, thin, simple peridium, bursting irregularly, with the branched, shrubby, reticulated capillitium adherent to it. Several species are British; they are rather large plants, growing over recently felled timber or on hollow trees, rails, &c. They grow with great rapidity.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 308; Fries, *Summa Veg.* p. 449; *Syst. Mycol.* iii. p. 83.

RETICULA'RIA, Carpenter.—Rhizopods with extensile granular protoplasm, extending and ramifying into minute pseudopodia, which meet and reticulate: such as *Lieberkuehnia*, *Gromia*, and FORAMINIFERA.

BIBL. Carpenter, *Introd. For.* 28; *Microscope*, 437.

RETINA. See EYE.

RHABDAM'MINA, Sars. See LITUOLIDÆ.

RHABDI'TIS, Duj. See ANGUILLULA.

RHABDOGO'NIUM, Reuss.—A three- or four-angled Orthocerine Foraminifer.

BIBL. Reuss, *Sitzung. Ak. Wien*, xliv. 367.

RHABDOM'ONAS, Fresenius.—A genus of Monadina, or it may be termed one of the Flagellata, or a spore.

Char. Rod-shaped, slightly falcate; anterior extremity the thickest; three prominent longitudinal ridges; green vesicles or granules occupy the anterior half of the body. Progresses in a straight line with a rotary or semirotary motion on its long axis. Filament one and a half times the length of the body. In stagnant water with Confervæ.

BIBL. Pritchard, *Infus.* p. 503.

RHABDONE'MA, Kutz.—A genus of Diatomaceæ.

Char. Frustules tabular, depressed, compound, fixed by a stalk arising from one of the angles, with interrupted vittæ (front view), vittæ capitate; valves transversely striate, striæ extending into the front view, and forming numerous longitudinal series.

Marine; upon Algæ. Striæ visible under ordinary illumination; the dark lines or vittæ correspond to more or less complete internal septa; frustules connected with each other by gelatinous cushions (isthmi).

Conjugation and the formation of sporangia have been observed.

1. *R. arcuatum* (*Striatella arcuat.*, Ralfs) (Pl. 13. fig. 18). Vittæ in two marginal rows, isthmi convex. Length 1-300″.

2. *R. minutum* (*Tessella catena*, Ralfs). Vittæ in two marginal rows; transverse striæ faint. Length 1-1200 to 1-960″.

3. *R. adriaticum.* Vittæ forming four rows (interrupted in the middle, and again between the middle and the margin on each side); transverse striæ distinct; isthmi concave. Length 1-480 to 1-170″.

BIBL. Kützing, *Bacill.* 126, and *Sp. Alg.* 115; Ralfs, *Ann. Nat. Hist.* xi. 455, and xii. 104; Smith, *Brit. Diat.* ii. 32; West, *Micr. Journ.* 1858, p. 186; Arnott, *Micr. Journ.* 1858, p. 91; Rabenht. *Fl. Eur. Alg.*

RHABDOPLEU'RA, Allman.—A genus of Polyzoa according to Allman, and of Hydroida according to Sars. It connects the two classes, and presents many features of great interest. Allman considers that its polypary resembles that of the Graptolites.

BIBL. Allman, *Qu. Mic. Jn.* 1874; Sars, *Qu. Mic. Jn.* 1874, p. 23; E. Ray Lankester, *Qu. Mic. Jn.* 1874, p. 77.

RHAGADOS'TOMA, Körb.—A genus of Micro-lichens parasitic on the thallus of *Solorina crocea.*

Char. Spores 2–4 (in lanceolate fugacious thecæ), large, simple, becoming 2-locular, colourless.

BIBL. Lindsay, *Qu. Mic. Jn.* 1869, p. 344.

RHAPHIDOGLŒ'A, Kütz.—A genus of Diatomaceæ.

Char. Frustules navicular, arranged in radiating crowded rows in a globose gelatinous mass. Marine.

R. micans (Pl. 14. fig. 11). Rows of frustules irregular, obsolete; valves linear-lanceolate, subulate, somewhat acute. Length 1-140″.

Three other species.

BIBL. Kützing, *Bacill.* 10; id. *Sp. Alg.* 97.

RHAPHONE'IS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, quadrangular, navicular; valves without a median aperture (nodule?); median sutural line longitudinal. Marine. = *Doryphora* without a stalk.

Eleven species.

BIBL. Ehrenberg, *Ber. d. Berl. Akad.* 1844, p. 74; Kützing, *Sp. Alg.* 49.

RHINOPS, Hudson.—A genus of Rotatoria.

BIBL. Hudson, *Ann. Nat. Hist.* January 1869.

RHINOT'RICHUM, Corda.—A genus of Mucedinei (Hyphomycetous Fungi), cha-

racterized by more or less clavate threads studded with spicules, to which the spores are attached. Several species occur in this country. A very beautiful rose-coloured species has lately been gathered in rabbits' dung.

Nematozonum, Desm., differs in bearing necklaces of spores.

BIBL. Berk. *Outl.* p. 348; Cooke, *Handb.* p. 590.

RHIPIDOPH'ORA, Kütz.—A genus of Diatomaceæ.

Char. Those of *Licmophora*, except that the frustules are each furnished with a distinct stipes; but as this is not always the case, the character is of little or no value. Marine.

Three British species (Smith); twelve others (Kützing).

R. paradoxa (Pl. 13. fig. 19). Stipes filiform, dichotomous; frustules in front view broadly wedge-shaped, somewhat acute at the base. Length of frustules 1-540 to 1-480″.

RHIZID'IUM, A. Braun.—A genus of Vaucheriaceæ, Unicellular Algæ.

Char. The thallus is at first unicellular, and then bicellular, and is furnished with delicate multipartite rootlets; vegetative cells oblong and narrow at the base; fructiferous cells beneath the apex of the others. Zoogonidia with a cilium. Two continental species, parasitic in *Euglenæ* and *Nitellæ*.

BIBL. A. Braun, *Monatsb.* 1856, p. 591; Rabenht. *Fl. Eur. Alg.* iii. p. 284.

RHIZ'INA, Fr.—A genus of Helvelloidei (Ascomycetous Fungi), distinguished from *Peziza* by the bullate hymenium, concave beneath, and furnished with rooting fibrils.

Two species have been found in this country, on sandy banks where the heath has been burnt.

BIBL. *Fr. Syst. Myc.* ii. p. 33; Curr. *Linn. Tr.* xxiv. p. 493; Cooke, *Handb.* p. 664.

RHIZOCLO'NIUM, Kütz.—A genus of Confervaceæ (Confervoid Algæ), distinguished by the decumbent habit and the short, root-like character of the branches.

Kützing includes here many of our British Conferveæ:

1. *R. rivulare*, C. Filaments simple, diam. 1-900″, fine bright-green bundles 2 to 3 feet long; in streams and rivers; common (Dillwyn, pl. 39).

2. *R. tortuosum*, Dillw. Filaments simple, diam. 1-800″, rigid, curled and twisted, forming large strata; in salt-water pools; abundant (Dillwyn, pl. 46).

3. *R. arenosum*, Carm. Filaments simple, diam. 1-1000 to 1-1800″; in dirty-green strata; sandy sea-shores.

4. *R. obtusangulum*, Lyngb. (Pl. 5. fig. 12). Filaments branched, diam. 1-1400″; pale-green, stratified; sandy sea-shores.

5. *R. riparium* (*Jurgensii*, Kütz.). Filaments branched, diam. 1-1400 to 1-1800″. Apparently not distinct from the preceding. On sandy sea-shores; not uncommon (*Engl. Botany*, pl. 2100).

6. *R. implexum*, Dillw. Filaments simple, diam. 1-2000″; bright green; forming large strata, on mountain-rocks (Dillw. *C. implexa*, tab. B).

7. *R. arenicolum*, Berk. (*Kochianum*, Kz.). Filament 1-2000 to 1-2400″; mountain-rocks (Berkeley, *Gleanings*, pl. 13. fig. 3).

BIBL. Harvey, *Brit. Mar. Alg.* p. 206, pl. 24 F; Kütz. *Sp. Alg.* 385; *Tab. Phyc. Brit. Flora*, ii. pt. 1. p. 354; Dillwyn, *Brit. Confervæ*; Rabenht. *Fl. Eur. Alg.* iii. p. 329.

RHIZOMOR'PHA.—The name given by authors to certain mycelioid expansions with a dark bark, which have been traced to *Polypori* and *Sphæriacei*. Many of the forms which occur in mines are remarkable for their luminosity.

BIBL. Berk. *Int. Crypt. Bot.* p. 266.

RHIZONE'MA, Thw.—A genus of Oscillatoriaceæ (Confervoid Algæ) = *Dictyonema*, Kütz. This curious plant (*R. interruptum*) differs from its allies by the gelatinous sheath being composed of distinct cells and furnished with branched root-like processes, which anastomose freely. The cell-contents are deep blue-green, with occasional yellowish interstitial cells.

BIBL. Thwaites, *Eng. Bot. Supp.* pl. 2954; Kütz. *Sp. Alg.* p. 321; *Tab. Phyc.* ii. pl. 40. fig. 5.

RHIZOPHORA'CEÆ.—A family of Dicotyledonous plants, to which belong the celebrated Mangrove-trees of the tropics. They are remarkable for the general occurrence of a ramified form of *liber-cell* (Pl. 39. fig. 31). The long woody radicles pushed out by the fruits, while still attached to the parent tree, contain a vast quantity of these ramified cells with very thick walls.

RHIZOPHYD'IUM, Schenk.—A genus of Vaucheriaceæ, Unicellular Algæ.

Char. Cellule ovate, globose, or broadly clavate, with two, three, or more orifices; either with or without distinct basal root-like processes. Propagation by zoogonidia.

Aquatic and parasitic in *Melosira*, *Navicula*, *Oscillaria*, *Zygnema*, &c., or non-parasitic and terrestrial on earth.

Bibl. A. Braun, *Monatsb.* 1855, p. 381; Archer (*Chytridium*), *Qu. Mic. Jn.* 1867, p. 89; Rabenht. *Fl. Eur. Alg.* iii. p. 281.

RHIZOP'ODA, Duj.—A class of the Protozoa, or a group of the Protista. It is badly defined as a class, because the presence of Pseudopodia, which is the grand characteristic, is noticed in minute beings which have other structural characteristics which prevent their being closely associated in a philosophical classification. The processes of protoplasm called pseudopodia are seen readily in *Amœba* and the freshwater Rhizopods; they exist in the Foraminifera, the Labyrinthula and Radiolaria, &c., in fact in most of the groups which Haeckel has separated so as to form his Protista. S. Müller classified the Rhizopoda as Polythalamia, Radiolaria, and Infusoria Rhizopoda. Max Schultze, before Müller, had grouped the Polythalamia, Monothalamia, and Athalamia as Rhizopoda; but the classification was insufficient. Huxley grouped together:—Rhizopoda with usually short pseudopodia, a nucleus, and a contractile vesicle (*Amœbæ*); the Foraminifera with long pseudopodia, which run into one another and become reticulated; and the Thalassicollæ, which are provided with structureless cysts containing cellular elements and sarcode (protoplasm), and are surrounded by sarcode giving off pseudopodia, which commonly stand out like rays, and which may and do run into one another. He considered that the Acinetæ, with their pseudopodium-like suckers, should be associated with the others. Carpenter divides the class into Lobosa (ex. Amœba), Radiolaria (ex. Polycystina), and Reticularia (ex. Foraminifera). Claparède and Lachmann group the class as follows:

Class Rhizopoda.

			Orders.	Families.
Without a calcareous test, no series of chambers, and no pores	Pseudopodia only uniting occasionally	No siliceous spicules; no yellow cellules	Proteina	1. *Amœbina.* 2. *Actinophryina.*
		Siliceous spicules; yellow cellules	Echinocystida	1. *Acanthometrina.* 2. *Thalassicollina.* 3. *Polycystina.*
	Pseudopodia forming a reticulate structure		Gromida	*Gromida.*
A test which is usually calcareous and divided into several chambers; even when one chamber, the walls are perforated by numerous pores			Foraminifera	1. *Monothalamia.* 2. *Polythalamia.*

The classificatory position of the Rhizopoda in Haeckel's Protista is perhaps the most satisfactory. See Protista.

Bibl. Dujardin, *Ann. Sci. Nat.* i., iii., iv.; Schultze, *Organis. d. Polythal.* Leipzig, 1834; Carpenter, *Phil. Trans.* 1856, 1859, 1862, and *Ray Society*; *On the Microscope*; Huxley, *on Thalassicolla*, *Ann. Nat. Hist.* 1851; *Elem. Comp. Anat.*; Williamson, *Trans. Mic. Soc.* 1852, p. 169, and vol. ii. p. 159; Wallich, *Ann. Nat. Hist.* 1864, xiii. p. 59, and *Mo. Mic. Jn.* i. 1869, p. 104; Reichert, *Ann. Nat. Hist.* x. 1862, p. 401; Kölliker, *Zeitschr. f. wiss. Zool.* 1849; Lieberkühn, *Zeitschr. f. wiss. Zool.* 1856, p. 308; Carter, *Ann. Nat. Hist.* 1856, 1857; *Trans. Mic. Soc.* 1849, p. 174; Müller, S., *Gesch. u. kritische Bemerk. ü. Zooph. u. Strahlthiere*, *Müll. Archiv*, 1858; Focke, *Physiol. Stud.* Bremen, 1854; Fresenius, *Beitr. z. mikr. Organ.* p. 224; Müller, *Ueber d. Thalass. Polycyst. &c. des Mittelm.*, *Monatsb. d. k. Akad. d. Wiss. zu Berlin*, 13 Nov. 1856, and his work with the same title, Berlin, 1858; Bailey, *Americ. Journ. Sci. & Arts*, vol. xv.; Claparède et Lachmann, *Etudes*; Haeckel, *Die Radiolarien*, Berlin, 1862; *Gener. Morphol.*; Archer, *Qu. Mic. Jn.* 1870, 1871. See *Bibl.* Protista.

RHIZOSOLE'NIA, Ehr.—A doubtful genus of Diatomaceæ.

Char. Frustules elongate, subcylindrical, marked with transverse or spiral lines, ends oblique or conical, and with one or more long terminal bristles; marine and fossil.

Four British species: *R. styliformis*, *R. imbricata*, *R. setigera*, and *R. alata.*

Rabenhorst takes no notice of the forms. *R. alata* (Pl. 42. fig. 43); *R. americana* (Pl. 41. fig. 46).

The British species were obtained from *Salpa*, *Ascidia*, and *Noctiluca.*

Bibl. Ehr. *Abh. d. Berl. Akad.* 1841, p. 291; Kütz. *Sp. Alg.* p. 24; Brightwell, *Micr. Jn.* 1858, p. 94.

RHODOM'ELA, Ag.—A genus of Rhodomelaceæ (Florideous Algæ), containing two tolerably common British species, with feathery, inarticulate, branched fronds, the

branches composed of concentric layers of oblong, colourless cells, with a cortical layer of minute coloured cells. Colour of *R. lycopodioides* purplish brown, becoming black; height 4 to 18″. Colour of *R. subfusca* brownish or reddish; height 4 to 10″. The *ceramidia* are stalked on the ramuli, occurring in summer; the *stichidia*, with tetrahedral tetraspores, occur in a similar situation in winter; the *antheridia* (observed in *R. subfusca*) also occur in tufts in the same position.

BIBL. Harvey, *Brit. Mar. Alg.* p. 78, pls. 11, 13; Tulasne, *Ann. des Sc. Nat.* 4 sér. iii. p. 20.

RHODOMELA'CEÆ.—A family of Florideous Algæ. Red or brown sea-weeds, with a leafy or filiform, areolated or articulated frond, composed of polygonal cells. *Fructification*: 1. *Conceptacles* (*ceramidia*) external, ovate or urn-shaped, furnished with a terminal pore, and containing a tuft of pear-shaped spores; 2. *antheridia*, borne in tufts in similar situations; 3. *tetraspores* immersed in distorted ramuli or in lanceolate receptacles (*stichidia*), usually in rows.

Synopsis of the British Genera.

1. *Odonthalia.* *Frond* flattened, linear, with an obsolete midrib, pinnatifid, alternately inciso-dentate.

2. *Rhodomela.* *Frond* cylindrical, inarticulate, opaque. *Tetraspores* contained in pod-like receptacles (*stichidia*).

3. *Bostrychia.* *Frond* cylindrical, inarticulate, dotted; the surface-cells quadrate. *Tetraspores* in terminal pods.

4. *Rytiphlœa.* *Frond* cylindrical, inarticulate, transversely striate. *Tetraspores* in pod-like receptacles.

5. *Polysiphonia.* *Frond* cylindrical, articulated wholly or in part; the branches longitudinally streaked. *Tetraspores* in distorted ramuli.

6. *Dasya.* *Frond* cylindrical, the stem inarticulate; the ramuli articulated, composed of a single string of cells. *Tetraspores* in pod-like receptacles (*stichidia*), borne by the ramuli.

RHODOSPORE'Æ. See ALGÆ.

RHODYME'NIA, Grev.—A genus of Rhodymeniaceæ (Florideous Algæ), containing seven British species, beautiful, brightly-coloured sea-weeds, growing on rocks or larger Algæ, having a flat membranous or somewhat leathery frond, ribless and veinless, of parenchymatous texture. Most are not more than 2″ high, but *R. laciniata* and *palmata* grow to 10″ and 18″. The colour is mostly rose- or blood-red. The *coccidia* are formed on the lacerated margins or the tips of lobes of the frond. The *tetraspores* form cloudy spots along the margin, or are scattered, tetrahedrally divided. The *antheridia* likewise form patches on the surface of the frond (observed in *R. Palmetta* and *palmata*).

BIBL. Harvey, *Brit. Mar. Alg.* p. 124, pl. 16 A; Thuret, *Ann. des Sc. Nat.* 4 sér. iii. p. 19, pl. 3.

RHODYMENIA'CEÆ.—A family of Florideous Algæ. Purplish or blood-red sea-weeds, with an expanded or filiform inarticulate frond, composed of polygonal cells; occasionally traversed by a fibrous axis. Superficial cells minute, irregularly packed, or *rarely* arranged in filamentous series. *Fructification*: 1. *Conceptacles* (*coccidia*), external or half-immersed, globose or hemispherical, imperforate, containing beneath a thick envelope a mass of spores affixed to a central column; 2. *antheridia*, collected in flat patches or sori; 3. *tetraspores*, either dispersed through the whole frond, or collected in indefinite cloudy patches.

Synopsis of the British Genera.

* Frond flat, expanded, leaf-like, dichotomous or palmate.

1. *Stenogramme.* *Conceptacles* linear, rib-like.

2. *Rhodymenia.* *Conceptacles* hemispherical, scattered.

** Frond compressed or terete, linear or filiform, much branched.

3. *Sphærococcus.* *Frond* linear, compressed, two-edged, distichously branched, with an obscure midrib.

4. *Gracilaria.* *Frond* filiform, compressed or flat, irregularly branched; the central cells very large.

5. *Hypnea.* *Frond* filiform, irregularly branched, traversed by a fibro-cellular axis.

RHOICOSPHE'NIA, Grunow.—A genus of Diatomaceæ, fam. Actinantheæ. Syn. *Gomphonema.*

BIBL. Rabenht. *Fl. Eur. Alg.* i. p. 112.

RHOIKONE'IS, Grun.—A subgenus of *Achnanthidium*, Ktz., comprising some species of Diatomaceæ, found in the South Pacific.

BIBL. Rabenht. *Fl. Eur. Alg.* i. p. 109.

RHOPALOM'YCES, Corda.—A genus of

Mucedines (Hyphomycetous Fungi), nearly allied to ASPERGILLUS, but having the

Fig. 618.

Fig. 619.

Rhopalomyces nigra.

Fig. 618. Tufts on wood. Nat. size.

Fig. 619. Fertile filaments. Magnified 200 diameters.

spores single (fig. 619), and not in moniliform series. The single spores are borne on minute spines (fig. 619, left-hand head). They are mildews growing over decayed wood, matting, dung, &c. Two (new) British species are described by Berkeley and Broome, found growing together.

BIBL. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. vii. p. 96, pl. 5.

RHUBARB.—Garden rhubarb (*Rheum undulatum*, and other species) affords, in the large edible petioles, excellent specimens of SPIRAL-fibrous STRUCTURES, spiral, annular, and reticulate vessels and ducts: these are readily isolated by the help of a needle from a fragment of cooked rhubarb placed in water on a slide, and are well seen by polarized light. The petioles and leaves likewise contain bundles of acicular RAPHIDES. The roots also contain special receptacles for a characteristic secretion.

RHYNCHOL'OPHUS, Dugès. = *Erythræus*, Latreille (not Dugès). A genus of Arachnida, of the order Acarina, and family Trombidina.

Char. Palpi large, free; labium penicillate; mandibles ensiform, very long; body entire; coxæ very remote, legs palp-like, *i.e.* dilated at the end, the posterior longest.

Species numerous; found in woods, under leaves, and in mosses.

R. cinereus (Pl. 2. fig. 40: *a*, labium with palp; *b*, tarsus; *c*, plume of labium more magnified; *d*, mandible).

BIBL. Dugès, *Ann. des Sc. Nat.* 2 sér. i. 30; Gervais, *Walckenaer's Arachnid.* iii. 175; Koch, *Deutschlands Crust. &c.*

RHYNCHONE'MA, Ktz.—A genus of ZYGNEMACEÆ (which see).

BIBL. Rabenht. *Fl. Eur. Alg.* iii. p. 229.

RHYNCHOP'AGON, Werneck (Rotatoria) = *Diglena* with a bilobed rostrum! Two species.

BIBL. Werneck, *Ber. d. Berl. Akad.* 1841, p. 377.

RHYTIS'MA, Fries.—A genus of Phacidiacei (Ascomycetous Fungi), growing upon the leaves of trees and shrubs, forming dark patches or spots on the surface, breaking through the epidermis with little scales or irregular fissures. *R. acerinum* is exceedingly common, forming large black spots on the leaves of the sycamore and maple; the thecasporous fruit is perfected (on the dead fallen leaves) in spring; MELASMIA *acerina*, which occurs in autumn, appears to be a preparatory form of this plant. *R. salicinum* is common on willow-leaves.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 290; Grev. *Sc. Crypt. Fl.* pl. 118; Fries, *Summa Veg.* 370; Tulasne, *Comptes Rendus,* March 31, 1852 (*Ann. Nat. Hist.* 2 ser. viii. p. 118).

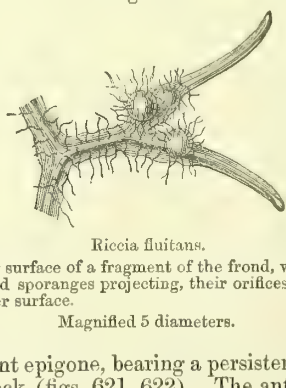
RICASOLIA.—A genus of Lichenacei, tribe Parmelini.

Char. Thallus lobate or laciniate, affixed by fasciculate rhizinæ. Stratum gonimon of small yellow-green gonidia; spermogonia in mastoid prominences.

BIBL. Leighton, *Brit. Lich. Flora,* p. 128.

RICCIA, L.—A genus of Riccieæ (Hepaticæ), consisting of minute green thalloid productions growing upon damp ground or floating on water, distinguished from the allied forms by the capsules being immersed in the substance of the frond, destitute of perichæte and perigone, while the archegone permanently encloses the sporange as an

Fig. 620.



Riccia fluitans.

Lower surface of a fragment of the frond, with three imbedded sporanges projecting, their orifices being on the upper surface.

Magnified 5 diameters.

adherent epigone, bearing a persistent style-like neck (figs. 621, 622). The antheridia

are globose sacs contained in special cavities, the orifices of which, narrowed into a neck, project as short processes from the surface (cuspides). The epigone being adherent to the sporange, the spores appear to lie immediately in the cavity of the former when

Fig. 621. Fig. 622.

Riccia fluitans.

Fig. 621. Vertical section through the frond and sporange contained in its substance.

Fig. 622. Sporange, with persistent epigone, extracted from the frond.

Magnified 25 diameters.

ripe; they are unaccompanied by elaters, and escape by irregular rupture of the epigone. Several species occur in Britain.

* *Terrestrial.*

1. *R. glauca*, L. Frond without membranous scales below, fleshy, ovate-oblong, two- to three-lobed, 1-2 to 1″ in diameter, the divisions dichotomous, growing in orbicular tufts, surface smoothish, punctate, glaucous green. On banks.

2. *R. crystallina*, L. Differing from the last chiefly in larger size and lighter colour, and having large cavernous air-cells opening widely on the upper surface. Damp mould.

** *Aquatic.*

3. *R. fluitans*, L. (fig. 620). Fronds without scales below, 1-2 to 2″ long, repeatedly forked, segments linear, notched at the ends; when placed on damp earth it produces radical hairs (fig. 621-2). Stagnant water.

4. *R. natans*, L. Fronds with long reticulated scales below, obcordate, 1-2″ long, or with the two lobes again divided; scales of the lower surface purple. On stagnant pools.

Bibl. Hook. *Brit. Flora*, ii. pt. 1. p. 102; Bischoff, *Nova Acta*, xvii. p. 909; Lindenberg, *ibid.* xviii. p. 361; Hofmeister, *Vergleich. Untersuch.* p. 43, pl. 10.

RICCIEÆ.—A tribe of Liverworts or Hepaticæ, consisting of delicate, green, membranous fronds, spreading on the ground or floating on water. The fruits are always sessile on the frond, more or less imbedded in its substance according to the thickness; the spores are unaccompanied by elaters.

Synopsis of British Genera.

1. *Sphærocarpus.* Archegones dorsal, on a lobed membranous frond, sparingly aggregated. Perichæte obtusely conical or pear-shaped; perforated at the summit, continuous with the frond. Perigone wanting. Epigone crowned by the deciduous style. Sporange at length free, indehiscent.

2. *Riccia.* Archegones immersed in the frond, scattered, neither emergent nor exposed on the surface until burst. Perichæte and perigone indistinguishable. Epigone crowned by the enlarged, long, persistent style, adherent to the sporange. Sporange bursting irregularly.

RICE.—This grain is produced by the grass called *Oryza sativa.* The seed is remarkable for the hard character of the albumen, which is explained at once when we examine a section under the microscope (Pl. 36. figs. 12 & 13). The cells are filled with very small starch-grains, which are packed so closely that they assume a parenchymatous form and present the appearance of a continuous tissue (as in maize). The cohesion of the starch-granules is the cause of the peculiar grittiness of rice-flour. See Starch.

RIMULARIA, Nyl.—A genus of Lichenacei, tribe Peridiei.

Char. Apothecia rotundate, depressed in the centre, dehiscing by a subradiate fissure.

Bibl. Leighton, *Brit. Lich. Flora*, p. 406.

RIMULINA, D'Orb.—A Nodosarine Foraminifer, with oblique chambers, and a long slit-like orifice on the edge of the last chamber. Adriatic.

Bibl. Parker, J. & B., *Ann. N. H.* 3. xvi. 15.

RIND.—This word is used to denote a structure intermediate between epidermis and bark,—a compound structure consisting of several or many layers of cells and even of distinct forms of tissue, but not presenting the characteristic kinds and mode of arrangement which occur in true Bark.

RIVULARIA, Roth.—A genus of Oscillatoriaceæ (Confervoid Algæ), subdivided by Kützing, and restricted to the forms in which there is a distinct *manubrium* or elongated cell next to the globular basal cell. As thus defined, it contains only a few aquatic species, the rest being trans-

ferred to Physactis, Euactis and allied genera.

1. *R. angulosa*, Roth. Frond floating, globose, dirty-green; manubria oblong and curved, or oblong-ovate and abbreviated; filaments torulose at the base, interruptedly articulated at the apex. *Eng. Bot.* 968.

2. *R. Boryana*, Kg. (Pl. 4. fig. 18). Frond globose, greenish brown; manubria large; sheaths ventricose, colourless, with plaited constrictions; filaments moniliform or interruptedly articulate, flagelliform. Frond as large as a cherry. *β. flaccida*, smaller, filaments flaccid, not interrupted. The following two are given as doubtful: *R. botryoides*, Carmichael, and *R. plana*, Harvey.

3. *R. plicata*, Harv. Frond densely gregarious, compresso-plicate, often hollow and ruptured, dark green; filaments spuriously dichotomous, attenuated.

Bibl. Kützing, *Sp. Alg.* p. 336; *Tab. Phyc.* ii. pls. 67, 68; Harvey, *Brit. Alg.* 1 ed. p. 150; Hassall, *Brit. Fr. Alg.* p. 262, pl. 64; *Eng. Bot. Supp.* pl. 2911.

ROBERTI'NA, D'Orb.—A modification of the Bulimine form of Foraminifera with long oblique chambers, 7–10 in the last whorl, and interdigitating; orifice comma-shaped. Recent and fossil.

Bibl. Carpenter, *Introd. For.* 196; Parker and Jones, *Phil. Tr.* clv. 375.

ROBULI'NA, D'Orb.—A common form of *Cristellaria*, in which the orifice is triangular.

Bibl. Williamson, *Rec. For.* 24 (*Cristellaria*); Parker and Jones, *Ann. N. H.* 2. xix. 289.

ROCCEL'LA, Ach.—A genus of Parmeliaceæ (Gymnocarpous Lichens), growing on maritime rocks, remarkable as furnishing the dye called orchil or archil. *R. tinctoria* and *R. fusiformis*, the British species, grow only in the extreme south of England.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 225; *Engl. Botany*, pls. 211, 728.

ROCKS.—Geologists include every mass of stratified and unstratified deposit, whatever its hardness may be, under the term "rock;" and rocks are divided and classified under four great classes—the igneous, aqueous, aërial, and the metamorphic—according to the nature of the agencies by which they have been brought into their present state and position. In studying the mineral masses termed rocks, it is necessary to inquire into their composition, texture, structure, and method of formation; and in doing this, the employment of simple magnifying lenses or of the compound microscope is of great importance.

Amongst the aqueous rocks are those which have been derived from the wearing down of previously existing strata; and these sediments afford to the microscopist evidence of the mineral matters contained in the older rock, and the manner in which the grains and more or less imperfect crystals are bound together, coloured, and enveloped in matrix in the produced mineral mass. In the same group are the strata and rocks which owe their mineral composition and general structure to the accumulation of the hard parts of organisms. Such are the calcareous deposits called chalk (see Chalk), and the siliceous strata containing Polycystina, and those deposits which are called Oolitic, in which unorganized calcareous mineral has collected around nuclei and been bound together by a calcareous matrix. All these kinds of rock afford abundant interest to the microscopist; and they may be observed after powdering, lævigation, and in some instances section-cutting and the action of dilute acids. The greatest interest, however, is attached to the examination of the igneous and metamorphic rocks; for some of their mineral constituents are usually invisible to the naked eye, and the general relation of the composing mineral is frequently not appreciable without careful section-cutting and polishing. The shape of the component crystals, their freedom from, or the nature of their cavities and contents, the kinds of minerals entering into the composition of the rock, their replacement by others which assume their form (pseudomorphs), their perforation by other crystals, and the influence of polarized light are readily discovered by following the methods of Sorby, Zirkel, Forbes, and others. Sorby is thus quoted by Beale:—

"Comparatively little can be learned of the structure of rocks and minerals from the examination of fractured surfaces by reflected light. Flat polished surfaces show very much more, but nearly all the important facts can only be observed by examining thin sections by transmitted light. What is really requisite is to have portions sufficiently thin, flat, and smooth to transmit light. In some cases fragments of clear minerals may be broken thin and flat enough to show certain facts very well when mounted in Canada balsam; and in this manner we may easily study the fluid-

cavities in quartz, or the structure of such rocks as obsidian and pitchstone. In many cases, however, we must have recourse to carefully prepared thin sections. The details of the method of preparing these must necessarily vary according to the mechanical means at the disposal of each person; and much time may be saved by the use of machinery. I shall therefore give such a general account as may be used by any one who has not machinery at command, premising that it will be easy to modify it in detail, according to the facilities which each may possess for employing more expeditious methods. In collecting specimens for examination, I find it convenient to break off portions from the rock as flat and thin as possible, so that they may be ground down at once; for otherwise it may be requisite to saw off portions with a lapidary's wheel, or by means of a straight toothless saw of sheet-iron with emery. Having made the specimen of a convenient size and form, with one side flat, this must be ground down perfectly level and dressed off very smooth. I usually avoid using any polishing-powder, since, if it were to work into cracks or cavities, it would be far more objectionable than any slight want of polish; if we attempt to grind down the surface on such a stone as should be used to finish off, very much time would be lost; and it is therefore best to use a series of stones of increasing fineness. I have generally used first fine emery on a plate of iron or zinc, then a kind of stone known by marble workers as 'Congleton,' after that a soft piece of Water-of-Ayr stone, and finally finish off on a very hard and fine-grained piece of the same kind. However, since it may be difficult to procure such stones, a flat slab of fine-grained marble, or different kinds of slate may be used. What is wanted is to finish off the surface so as to be free from scratches and almost polished, with the hardest and the softest portions ground down to the same level. If not dressed smooth by slow grinding, the hard portions will stand out in relief, and, when the section is finished, the soft parts may be all ground away before the hard are sufficiently thin, and the structure of the rock may be quite misunderstood. Having duly prepared one flat surface, it should be fastened down on a piece of glass with Canada balsam. This should be kept hot until it is so hard as to be just brittle when cold. I find it best to remove, time after time, a small piece, until it has become so hard that when cold it can be rubbed to powder between the thumb and finger. The piece of stone should be made hot, but no hotter than needful, so that liquid may not be expelled from the fluid-cavities; and balsam should be spread over the flat surface, and kept hot for awhile, which penetrates into the softer parts and hardens them. Before fixing the specimen on the glass, it is well to remove this balsam, and fasten it down by that on the glass. I find it much the best to use square pieces of glass. The usual 3-inch-by-1 glasses are very unsuitable for the purpose; since they are much too long in one direction, and too short in the other. I use glasses $1\frac{5}{8}$ inch square, and generally make sections about 1 inch square, which is a very suitable size. Since the section ought not to be removed from the glass, care should be taken in grinding down not to scratch the glass. This may be avoided by fastening small bits of sheet-zinc at each corner with balsam, and grinding the stone with emery until they all come flat down on the plate. The stone is then equally thin all over; and having removed the bits of zinc, it must be further ground down on the stones until of the proper thickness, and the upper surface finished off in the manner already described. The thickness must depend very much on the nature of the rock. If coarse-grained and composed of comparatively transparent minerals, $\frac{1}{100}$ of an inch may not be too thick, whereas some very fine-grained and opaque rocks should be not $\frac{1}{1000}$ of an inch. Of course it is requisite so to grind them down as not to break up or disturb the different constituents; and since some parts may be very hard and some very soft, it is impossible to prepare perfect sections unless they are slowly ground down on a fine-grained stone, which may gradually wear away the hardest parts without injuring the softest. After having finished the section, I find it often better to keep it some time before I mount over it a thin glass cover, in order that the balsam may become quite hard. I then melt some balsam at a gentle heat on a thin glass cover of proper size; and just before I place it on, I wet the surface of the section with a drop of turpentine, which soaks into the pores so as to make it more transparent, and renders it much easier to fasten down the glass without any bubbles. This must be done at a very gentle heat, so as not to

cause the section to break up by melting the balsam which holds it fast to the glass plate. Sections of very soft rocks which would easily break up in water may be prepared in the same manner by hardening them with balsam. They should be first soaked with turpentine, and then with soft balsam, and kept hot until quite hard. We may modify the above plan with advantage in preparing sections of such hard minerals as quartz. If ground down with emery and water, deep scratches are produced, and it takes a long time to remove them by means of the softer stones. This may be avoided by using fine emery paper, held flat on a piece of plate glass. After grinding down to nearly the proper thickness with emery and water, common English flour-emery paper may be used, which soon removes the deep scratches; and afterwards the surface may be almost polished by using the finest French emery paper employed in preparing steel plates for engraving; a perfect polish can then be easily given by means of rouge on parchment. Crystals of salts soluble in water may also be ground down and dressed smooth on emery paper, and finally polished with rouge in the same manner; but in many cases they may be examined without this preparation, and may be fastened on glass with balsam. Some are decomposed by contact with balsam, and must be kept dry in small covered cells; others may be mounted in a concentrated solution of the same salt, when it is desirable to retain the liquid enclosed in the fluid-cavities; and when very small they may be mounted in Canada balsam, or, if that be objectionable, in castor-oil. Sometimes the structure of a rock or other mineral substance may be studied to great advantage by grinding it to a suitable shape, moderately thick and flat, fixing one side to glass with balsam, and acting on the other with a dilute acid. If one part is soluble and the other not acted on, some valuable facts may be learned. As an example, I refer to the *Eozoon Canadense,* which has lately attracted so much attention. One part consists of carbonate of lime, and the other of siliceous minerals insoluble in diluted acid; and when the former is dissolved a most beautiful and minute structure may be seen, which appears to be due to minute tubes and other open spaces filled with the insoluble minerals."

Igneous rocks may, as a rule, be distinguished from all others by their structure, which is that of a more or less perfect network of minute crystals. In many cases all the minerals constituting the rock are well crystallized; and in others there is an amorphous or glassy base in which they are enclosed. There are, however, other rocks, such as the felstones and the more recent volcanic phonolites, some of which do not present the crystallized arrangement of their minerals; and there are the porphyrites, which are characterized by the presence of crystals of felspar in a compact felspathic base. The ordinary basalt called Rowley Rag, Allport shows to present in thin sections a triclinic felspar, which exhibits the characteristic striæ to polarized light, augite in minute bright brown or greenish crystals differing from the crystals of hornblende in their glassy and non-fibrous appearance and in the angles, magnetite in minute black opaque grains or laminæ, apatite in long, acicular, hexagonal crystals, and olivine both in crystals and irregular grains of a clear yellowish-green colour or dark green. In addition there are one or two zeolites, calcite, and chloritic minerals, all of which are in cavities. In this Rag the minute crystals of apatite penetrate the felspar and the augite, and the latter also encloses crystals of felspar and magnetite. The augite, therefore, crystallized after the others were formed. The olivine contains grains of magnetite only, and was probably the second to crystallize. Cases are not uncommon in which crystals have caught up portions of the surrounding mass while in the act of formation. For example, in a section of pitchstone from Planitz, containing crystals of felspar, the minute opaque particles, thickly scattered through the matrix, are crowded together round the sides of the crystals, having been forced outwards as the latter increased in size; this clearly indicates that during the formation of the crystals the matrix was in a viscid but not in a fluid state; for had the particles been free to move, there would have been no crowding (Allport).

Polarized light is of immense importance in the examination of rocks and minerals. It enables us at once to discriminate between different minerals, and not unfrequently affords clear evidence of changes which have taken place subsequently to the consolidation of the substance under examination. The peculiar and irregular arrangement of the crystals in igneous

rocks sometimes interferes, but usually is favourable to the examination by polarized light. Moreover pseudomorphs or minerals which possess the crystalline form of the mineral they have replaced, do not have the molecular arrangement of the original, and therefore act differently on light. Hence they can be distinguished in the sections.

Allport sums up the results of his microscopical investigations as follows :—The mineral constituents of the melaphyres and other fine-grained igneous rocks may be determined with certainty; the mineral constituents of the true volcanic rocks and those of the old melaphyres are generally the same; and the old rocks have almost invariably undergone a considerable amount of alteration, and this change alone constitutes the difference now existing between them and the more recent basalts.

Slate, felsite, and elvanite from Waterford were examined by J. A. Phillips. He thus describes a section of slate which was made parallel to one of its lines of cleavage:—It consisted of an amorphous matrix through which a floculence of a dirty green colour, probably chlorite, was disseminated; a few well-defined quartz crystals were present. A metamorphosed slate, whose cleavage-planes had been obliterated, he found to consist of felspathic-looking crystals crossing each other in all directions, with minute scales of chlorite here and there. These crystals readily depolarized light and were transparent.

The elvanite in section, under an ½-inch object-glass, is composed, according to the author, of an amorphous greyish matrix, in which are imbedded (like porphyry) crystals of quartz and oligoclase felspar, and some crystals of a hornblendic mineral are interspersed. The larger quartz crystals are sometimes penetrated by felspar and hornblende crystals, and a high power proves the existence of fluid-cavities in the quartz. The felsite sections presented a colourless amorphous matrix, enclosing a few dodecahedral crystals of quartz and some small crystals of felspar; and other portions of the matrix were indistinctly crystalline and enclosed a few laminæ of chlorite.

Sections of crystals and gems enable microscopic crystals to be observed within them. Thus Isaac Lea (Proc. Acad. Nat. Sci. Philadelphia, 1869, and Mo. Mic. Jn. viii. p. 164) found minute acicular crystals in garnets. In a sapphire with six rays he found crystals of pearly lustre at three different angles; these produce the bands which form the rays in three directions of 60° each. In a bluish sapphire he discovered arrow-headed crystals and in a ruby acicular crystals. He supposes that the acicular crystals in garnets may be rutile. Göppert alleges that the greenish round corpuscles seen in diamonds when examined with a sufficient power, are vegetable in their origin. He even gives distinct specific names to one which resembles a *Protococcus*, and to another which is like unto a *Palmoglœa.*

BIBL. *Untersuchungen über d. mik. Zusammensetz. u. Struct. d. Basalt-Gesteine*, Bonn, 1870; *Mickromineral. Mittheil., Neues Jahrbuch f. Mineralogie*, 1870; Vogelsang, *Sur les Crystallites, Archives Néerlandaises*, 1870; Fischer, *Mik.-mineral. Stud.* Freiburg; Tschermak, *Mik. Unterscheid. d. Mineral. aus der Augit, Amphibole u. Biotitgruppe, Proc. Vienna Acad. of Sci.* 1869; Geikie, A., *Nature*, Feb. 1871; A. Kenngott, *Phil. Mag.* Dec. 1869; J. A. Phillips, *Mo. Mic. Jn.* 1870, p. 166; Sorby, *Mic. Struct. of Crystals, Qu. Journ. Geol. Soc.* vol. xiv.; *On Rocks, Mo. Mic. Jn.* 1870, p. 148; Allport, *On Rocks, Mo. Mic. Jn.* 1870, p. 98; Allport & Phillips, *On Phonolites, Geol. Mag.* June 1871, *Mo. Mic. Jn.* 1871, p. 87; Allport, *On Pitchstones, Geol. Mag.* Jan. 1872; Forbes, *Pop. Sc. Rev.* 1867, and *Mo. Mic. Jn.* i.; Phillips, *Phil. Mag.* 1871, *Mo. Mic. Jn.* 1871, p. 183; Crookes, *Mo. Mic. Jn.* ii. p. 111; King, *Geol. Mag.* 1873, p. 19; E. Hull, *Geol. Mag.* 1873, p. 193.

RŒSTE'LIA, Rebent.—A genus of Uredinei (Coniomycetous Fungi), closely related to ÆCIDIUM, and presenting similar spermogonia and perithecia; the chains of spores of the *Rœsteliæ*, however, present a peculiarity,—having a sterile joint, forming an isthmus of variable length, between each spore: the peridium bursts irregularly; or (in *R. cancellata*) the teeth cohere more or less for a time, so as to form a kind of lattice. This genus includes *Æcidium cornutum, laceratum*, and *cancellatum* of older authors, growing respectively on the leaves of the mountain-ash, hawthorn, and pear. See ÆCIDIUM and UREDINEI.

ROOTS.—The anatomy of roots presents important modifications; but these are less striking than those met with in stems. In all cases they have a fibro-vascular axis enveloped in a more or less thick cortical

parenchyma, covered when young by a delicate epidermis devoid of stomata (sometimes called epiblema), when old by an epidermal tissue of corky nature. The roots of the vascular Cryptogamia (Ferns, Lycopodiaceæ, &c.) are all adventitious; and their structure consists merely of a central fibro-vascular axis, surrounded by a cellular cortex and an epidermis provided with numerous root-hairs of a yellowish colour. Dicotyledons produce an axial root, which is a direct prolongation of the stem downwards; and both this and the adventitious roots frequently developed on the stem have the peculiar unlimited fibro-vascular structure found in the stems of this class, and may become woody and increase by annual layers like the ascending axis. The radicle of a monocotyledonous embryo is never developed; but if we make a section of the lower part of the embryo, we find one or more little conical bodies imbedded in the parenchyma; these are the nascent adventitious roots, which soon appear externally by breaking their way mechanically through the superficial tissue. The anatomy may, however, be more easily studied by tracing the development of the adventitious roots on the rhizomes of rushes, flags, and other plants of this class. The roots originate in the region where the fibro-vascular bundles of the stem terminate (and frequently form a fibrous plexus). They are at first wholly cellular, and we may distinguish in them three parts:—a woody axis, which soon becomes continuous with the fibro-vascular plexus; a cortical parenchyma, continuous with the inner part of that of the parent stem; and a kind of conical hood of rather dense cellular tissue enveloping the end of the root. As the root grows it pushes the hood forward, which breaks down the cellular tissue before it, and finally appears externally. When the epidermis is ruptured in this way, it presents a circular free edge standing up slightly like a collar around the base of the free part of the root: this is called the coleorhiza by some authors. The conical hood upon the apex of the root, called the pileorhiza, is more or less persistent in different cases; in aquatic plants it becomes greatly developed, as may be seen in the duckweed (*Lemna*), where it forms a long sheath, appearing as if slipped over the end of the rootlet. The focus of development of the root is within the pileorhiza, which is pushed forward by the continued development of cells just behind the apex. The pileorhiza may be compared to a kind of shield or guard to the tip of the root, protecting the nascent tissue, by the expansion of which it is pushed forwards, itself always possessing a certain solidity, which enables it to penetrate between the particles of the soil. In a cross section of the root of a Monocotyledon we see the centre occupied by prosenchymatous tissue with a circle of vessels around it, the whole enclosed by regular parenchyma, sometimes by liber-cells and covered by an epidermis. The ring of vessels spreads out into a kind of rosette at the base, and anastomoses with the extremities of the fibro-vascular bundles of the stem in the fibrous region. Secondary adventitious roots are formed in the same way in the roots, originating immediately upon the vascular ring and breaking through the cortical parenchyma. The woody adventitious roots of arborescent Monocotyledons differ only in the greater development of the fibro-vascular structures; and they emerge from the stem (palms) in the form of thick conical shoots. In the thickened adventitious roots of asparagus, which perform the function of tubers, the parenchyma is greatly developed. In the tuberous roots of Orchids the central woody axis becomes irregularly expanded into parenchymatous tissue, driving the vessels out nearly to the periphery, so that the characteristic structure is greatly disguised. The aërial roots of the epiphytic Orchids have the growing extremities clothed by several layers of a parenchymatous tissue, in which the cells are characterized by delicate open spiral-fibrous secondary layers. The axial root of Dicotyledons, being a direct continuation of the stem, displays a circular group of fibro-vascular bundles as in the ascending axis; but these mostly converge at the point of junction of stem and root (collar), so that the central axis of the parenchyma, the pith, is usually absent, the medullary rays remaining as in the stem. Externally, again, there is a difference, since the liber-bundles vanish and the cambium-region passes at once into the cortical parenchyma, here colourless and succulent, and this is clothed by a less prominent periderm than the stem. The roots of Dicotyledons increase in diameter by annual layers of wood formed in the fibro-vascular bundles, these, however, being much less regular in their arrangement than those of the stem on account of the tortuous course of the roots; hence, while the wood of the

roots is often useful for ornamental purposes, it is comparatively valueless for carpenters' uses. The branches of the axial root are originally growths from the apex of the root thrown off to the sides as it were, and their woody axis is derived from a division of that of the main root. The radical of a germinating Dicotyledon has its pileorhiza, and grows, in the same way as that of the Monocotyledons, by development of cells just behind the apex. Young roots are covered by a delicate epidermis; and the cells of this are abundantly produced into hairs (fibrillæ) in many plants, especially in those growing on light soils; these fibrils are deciduous, the delicate epidermis (which is always destitute of stomata) being gradually converted into a corky layer. Adventitious roots are very common in Dicotyledons, especially the herbaceous perennial kinds, and they alone can exist on plants raised from cuttings &c. of stems. The roots originate much in the same way as those of the Monocotyledons, appearing first as cellular cones in the region adjacent to the cambium-layer, with which the fibrovascular structure soon becomes confluent. They break through the rind with a coleorhiza, and protected by a pileorhiza, just as in Monocotyledons; but when once formed they appear to branch in the same manner as the axial root, and not by the formation of secondary adventitious roots.

The structure described under the name of spongioles has no existence in nature. The error has probably arisen from the appearance presented by the pileorhiza. Roots grow by cell-development only near the apex; and interstitial expansion soon ceases. Old roots of Dicotyledons present a dense heart-wood like the trunks, the passage of fluid taking place through the outer layers. When the older parts of roots are exposed to the air by removal of soil, they acquire a thick corky periderm. The general structure of the root of Conifers is like that of Dicotyledons.

BIBL. Henfrey, *Elem. Course* (Masters).

ROTA'LIA, Lamarck (restricted).—A typical Foraminifer; shell ammoniform, neat, finely porous, unequally biconvex; with 13–40 chambers, double septa, and canal-system; limbate and often granulate.

Species numerous, both fossil and recent (*R. Beccarii*, Pl. 47. figs. 13, 14).

BIBL. Carpenter, *Introd. For.* 212; *Microscope*, 504; Parker & Jones, *Phil. Trans.* clv. 387.

ROTALI'NA, Carpenter (*Rotalinæ*).—A subfamily of the *Globigerinida*. See FORAMINIFERA.

BIBL. Carpenter, *Introd. For.* 198; Parker & Jones, *Phil. Trans.* clv. 378.

ROTATION or CYCLOSIS.—This term is usually employed in botanical works to denote peculiar flowing movements of the contents of vegetable cells; and it is useful to retain the word for all the cases of the kind, in order to avoid confusion of these phenomena with the general circulation of the sap. The term "circulation of the cell-sap" is, however, often used instead of rotation, and especially in reference to the cases where it exhibits numerous distinct currents.

The rotation presents itself in two types, namely—(1) a rotatory movement of a layer of protoplasm investing the entire internal surface of the cell, as in CHARA, &c.; and (2) a radiating movement of the protoplasm in slender currents, from the nucleus out over the remainder of the cell, with a return flow towards the nucleus: but as the nucleus itself shifts in the latter type as in the former, the two kinds are scarcely definitely distinguishable; they may, however, be spoken of separately.

The rotation in *Chara* (and *Nitella*) has been long known; a similar movement occurs in many water-plants, such as *Vallisneria*, *Hydrocharis*, *Anacharis*, *Stratiotes*, *Sagittaria*, *Potamogeton*, *Ceratophyllum*, &c., where it is seen best in the more delicate foliaceous structures, such as young leaves, stipules, or sepals, or in the young rootlets. It has also been observed in the fruit-stalks of *Blasia pusilla* and some other Hepaticæ.

In the CHARACEÆ the wall of the cells is lined with chlorophyll-granules, leaving two oblique or spiral striæ bare (fig. 125, p. 156); these striæ indicate the boundaries of the ascending and descending currents (marked by arrows). The moving substance is a viscid semifluid layer lying within the chlorophyll-layer, and itself surrounding the watery cell-sap occupying the centre of the cell. This layer, forming a kind of gelatinous sac, moves in a spiral course up one side of the cell and down the other, the motion being rendered very evident by chlorophyll- and other granules imbedded in it; these appear to be carried along passively by the stream, the larger slowly, the smaller with greater rapidity. In *Vallisneria*, *Anacharis*, &c. the chlorophyll-granules and the nucleus are imbedded in and moved with the flowing protoplasm. If long cells of *Chara*

are bent or tied round by a ligature, the circulation is not stopped, but takes place independently in each half. If a cell of *Chara* is cut across, the protoplasm of the current flowing towards the cut surface escapes at once, but that of the current flowing away, goes on to the end of the cell, turns round, and then flows towards and out from the wound.

The size of the stream seems to be in inverse proportion to the length of the cell, decreasing as the latter acquires its full development. The rapidity of the current varies according to the age of the plant and the activity of its vegetation. It is most rapid in hot weather and in sunshine. Artificial elevation of temperature in the water in which the plant grows, up to a certain point, hastens the movement; a heat above 80° Fahr., however, retards it for a time. A temperature of 112° Fahr. kills the plant, as also does a cold of about 20°. Darkness appears merely to exert effect through its influence on the activity of the vegetation. Keeping *Chara* in water exhausted of air does not stop the rotation until the plant dies. Most chemical reagents seem to exert no special action; only lime-water appears to stop it in a few moments. A solution of sugar, or gum, or milk greatly hastens the rotation in *Vallisneria*, so that the protoplasm is moved on in waves; but the primordial utricle finally dissolves, and the movement ceases. Passing an electric current through the cell stops the current for a time; but it recovers itself, just as occurs after any mechanical interference. If several cells are injured by cutting or pricking, the whole rotation stops in young plants, but it gradually returns as before in the uninjured cells. Pressure interrupts or stops the motion for a time only; when removed, the current is gradually restored; but actual injury to the cell stops it for ever.

The rotation which takes place between the external surface of the green layer and the outer cell-membrane in *Closterium* and other DESMIDIACEÆ appears to be of the same kind as the above.

The circulation in reticular currents, first observed by Mr. Brown in the hairs of the stamens of *Tradescantia*, appears to exist far more extensively, if it be not even a universal phenomenon. It has been observed in the Confervoideæ, Fucoideæ, Florideæ, Lichens, Fungi, Hepaticæ, Equisetaceæ, Lycopodiaceæ, and Ferns, and in the most varied families of Flowering plants. It is seen most easily in young tissues, especially such as can be prepared readily without much mechanical injury; for example, in hairs, cells of the pulp of fruits, cells of the germen of Onagraceæ, of the labellum of Orchids, &c. It generally exhibits the following characters:—In the middle or at one side of the cell occurs a large heap of protoplasm, in which is imbedded the nucleus; from this protoplasm more or less slender filaments run out over the cavity of the cell, and as these contain numerous fine granules, a flowing movement which takes place becomes evident by the change of place of the granules. Attentive examination shows that these flow out from the central mass and return to it, and, moreover, that the currents change their form and direction, and, lastly, that the nucleus itself moves. This rotation cannot be observed in very young cells when the cavity is densely filled with protoplasm; but Hofmeister states that he has seen the entire primordial utricle rotate in the special parent cell of the spore of *Phascum cuspidatum*. As the young cells increase in size, vacuoles are formed in the protoplasm, filled with watery sap; and these enlarging and becoming confluent, leave the protoplasm in the form of a reticulated mass.

Beale has shown that the stream in *Vallisneria*, which moves round and round the cell, and which resembles water under 1-12″ object-glass, is proved under 1-28″ or 1-30″ to consist of fluid holding in suspension numerous minute moving particles.

The cause of the motion is evidently related to the movements exhibited by free protoplasmic bodies, such as ZOOSPORES, SPERMATOZOIDS, the free filaments of OSCILLATORIA, &c. It has been well compared with the movements of the body of *Amœba*, which bear considerable resemblance to some kinds of the reticular rotation. The relation existing here is further borne out by the fact of pulsating vacuoles existing in *Volvox*, *Gonium*, &c., just like those in the Infusoria.

The actual rotation or movement in a definite direction is the result of the confining cell-wall on the contracting and expanding protoplasm. It is produced in Algæ during cell-growth.

The rotation in *Chara* may be observed by simply placing portions of the plant on a slide in water. The unencrusted species are of course most favourable; but the growing points of the others are tolerably transparent. In *Vallisneria*, detached fragments of

leaves, or even horizontal sections of the leaf, may be used; in *Anacharis* entire leaves or sepals may be detached and observed. Hairs are frequently more or less covered with a viscid secretion, which retains air-bubbles about them; in such cases, it is often useful to dip them for an instant in alcohol, and then place them in water.

BIBL. Varley, *Trans. Soc. of Arts*, xlviii. (1832); *Mic. Trans.*; Slack, *Trans. Soc. Arts*, xlix.; Dutrochet, *Comptes Rendus*, 1837, p. 775; Becquerel, *ibid.* p. 784; Unger, *Sitzungsber. d. Wien. Akad.* viii. p. 32; Mohl, *Bot. Zeit.* iv. p. 73 (1846); *Ann. Nat. Hist.* xviii. p. 1; Hofmeister, *Vergleich. Unters.* p. 73; Osborne, *Mic. Journal*, iii. p. 54 (1854); Branson, *ibid.* iii. p. 260 (1855); Wenham, *ibid.* iii. p. 250; Henfrey, *Ann. Nat. Hist.* 3 ser. i. p. 419; Reichert, *On Circulation in Cells of Plants*, *Ann. Nat. Hist.* 1867, xix. p. 10; Beale, *How to Work*, 4th edit. p. 165; Carpenter, *Microscope*; Henfrey, *Elem. Course* (Masters), p. 551.

ROTATO'RIA or ROTIF'ERA. — A subclass of Annuloida.

Char. Microscopic, transparent animals living in fresh or in salt water; legs absent; anterior portion of the body furnished with a retractile, often lobed disk, upon which are placed usually vibratile cilia, when in motion presenting the appearance of one or more revolving wheels; alimentary canals usually distinct, with a dental apparatus, and two orifices; reproduction by ova.

Body covered with a firm and usually smooth skin or integument, sometimes presenting indications of segments; often more or less enclosed in a carapace (CARAPACE), which is either secreted by the skin, by the alimentary canal, or by a special secreting organ. In some species the skin is furnished with cilia, hairs, or rigid bristles.

In most, there is a tail-like process at the posterior end of the body called the foot-like tail, tail-like foot, or false foot; this is jointed, and can often be contracted and extended like a telescope; it does not form a direct prolongation of the end of the body, but arises from and is situated upon the ventral aspect. It is often terminated by a suctorial disk, or a pair of claw- or toe-like processes.

Distinct longitudinal and circular muscular bands are present; and they sometimes present transverse striæ.

The rotatory disk or wheel-organ varies greatly in structure, the varieties forming characters of the families and genera.

Its margin is usually furnished with one or two rows of vibratile cilia; sometimes these are replaced by bundles of non-contractile elongate cilia (Pl. 34. fig. 32), or the rotatory organ is divided into tentacle-like processes, upon which cilia are placed (Pl. 34. fig. 25).

It is the uninterrupted succession of strokes given by the cilia of the disks, each row of which nearly returns (as it were) into itself, that gives rise by an optical illusion to the notion of wheels (Carpenter, *The Microscope*, p. 469).

The rotatory disk is the principal organ of motion, by means of the cilia of which the animals swim through the water; some of the Rotatoria, however, move in a leech-like manner, by alternately fixing the toe-like processes and the anterior end of the body, which in some forms a kind of proboscis (Pl. 34. fig. 1).

The nervous system is not well known. It appears to consist of a ganglion and of branches given off in various directions.

In many of the Rotatoria, eyes are present, mostly red. These appear to have a cornea and a lens. They sometimes disappear in the adult animals; and as their number, position, &c. are used as characters, when absent in the adults, they must be looked for in the young or the ova, either within the carapace or adherent to the body.

Alimentary apparatus.—Behind the mouth is sometimes a distinct conical pharynx, but nearly always a rounded muscular gizzard containing the jaws and teeth. In the pharynx are occasionally seen two undulating lines, presenting a flickering appearance, the indications of cilia or undulating membranes. The jaws are constructed mostly after two forms. In one of these they consist of two knee-shaped pieces (Pl. 34. fig. 24),—to the posterior portion of which muscles are attached, whilst the anterior, which passes inwards at a right or obtuse angle to the former, ends in a single point or in several teeth (fig. 26). In the other, the jaws have the form of stirrups (Pl. 34. fig. 17), with their bases turned towards each other, upon which two or more teeth are placed. A third single or compound intermediate piece forms a support (Pl. 34. figs. 24, 26), upon which the food acted upon by the jaws is triturated. In some species the jaws and teeth are very complex in their arrangement.

The alimentary canal is usually short and straight, but sometimes curved. Its walls are very thick, and lined with ciliated epi-

thelium. The stomach forms a distinct expansion (Pl. 34. fig. 27 *c*); this is succeeded by an intestine, the termination of which corresponds to a cloaca, receiving the expelled contents of the reproductive organs and so-called water-vessel system, and opening at the base of the foot. In some Rotatoria a second expansion or stomach is situated below the upper one.

The walls of the stomach and intestine frequently contain brown or yellow cells, representing a liver; and at the commencement of the stomach are two or more cæcal appendages, probably corresponding to a pancreas (Pl. 35. figs. 14, 34).

In the male Rotatoria, the alimentary canal is entirely absent.

Vascular system.—Distinct blood-vessels are apparently not present in the Rotatoria; but on each side of the body, in most of them, runs a narrow straight or wavy band, containing a slender vessel (Pl. 34. fig. 18 *a*; Pl. 35. fig. 14 *b*). Anteriorly, these vessels give off branches, the terminations of which are not well known. By some they are said to open into the abdominal cavity, by others to terminate as cæca. Attached to the walls of these lateral tubes, or situated within them, are pear-shaped or oval corpuscles (Pl. 34. fig. 18 *a*; Pl. 35. fig. 14 *c*), which exhibit a flickering appearance from the action of cilia connected with them, and which open into the cavity of the abdomen. Posteriorly, the tubes terminate in an actively contractile sac, which opens into the cloaca. In regard to their function, these tubes have been variously viewed, as water-vessels, testes, and kidneys. Ehrenberg considered them as connected anteriorly with a certain projecting organ (Pl. 35. fig. 14 *a*), situated usually in the cervical region (Pl. 34. fig. 3; Pl. 35. fig. 17), denominated the calcar or respiratory tube, and terminated by a retractile tuft of non-vibratile cilia (Pl. 35. fig. 5 *a*). They have no relation, however, with this, which corresponds to an antenna. Huxley proved that they are part of a water-system.

Beneath the integument of the Rotatoria, a kind of irregular circulation, varying with the motions of the body, or a simple molecular movement of minute granules, has been noticed. These granules are probably situated in the abdominal cavity; in which also sarcodic globules, sometimes free, at others connected by filaments, have been observed.

Reproduction.—The Rotatoria are propagated by means of sexual organs, and are unisexual. The female organs consist of one or two longer or shorter ovarian sacs or ovaries, situated towards the posterior end of the body in the abdominal cavity, the oviduct terminating in the cloaca, or at a distinct vulva. The ova are of an oval form, and are sometimes smooth externally and soft. The winter-ova are larger, darker than those hatched during the summer, and the outer coat is thick and hairy or tubercular. The winter-ova which remain so long attached to the posterior part of the body are probably gemmæ; they sometimes remain adherent to the cloaca for a time, and in a few instances they are hatched within the ovary.

The testis is situated at the posterior part of the body, and consists of a wedge-shaped body, with a muscular duct opening externally.

Many of the Rotatoria are remarkably tenacious of life; and some of them are stated to have revived after having been kept dry for several years.

Perfect desiccation destroys the Rotifers, but they will last long with a very slight amount of moisture.

The families of the Rotatoria are thus distinguished:—

Ciliated margin of rotatory disk simple or continuous.
 Margin entire. *Holotrocha.*
  Carapace absent.................. 1. Ichthydina.
  Carapace present .... 2. Œcistina (?).
 Margin undulate or excised. *Schizotrocha.*
  Carapace absent.................. 3. Megalotrochæa.
  Carapace present .... 4. Flosculariæa.
Rotatory disk divided or multiple.
 Divided into several parts. *Polytrocha.*
  Carapace absent.................. 5. Hydatinæa.
  Carapace present .... 6. Euchlanidota.
 Divided into two parts. *Zygotrocha.*
  Carapace absent.................. 7. Philodinæa.
  Carapace present .... 8. Brachionæa.

See Albertina.

They are found wherever water exists, provided it be not in a state of putrefaction,—thus in pools, on moist earth, mosses, in gutters, &c., and even in the cells of mosses and algæ.

Bibl. Ehrenb. *Infus.*; Dujard. *Infus.*; Siebold, *Vergleich. Anat.*; Dalrymple, *Phil. Trans.* 1849, 331; Huxley, *Trans. Micr. Soc.* 1852, i. 1; Williamson, *Micr. Jn.* i. 1; Cohn, *Siebold and Kölliker's Zeitsch.* vii. 431; Gosse, *Trans. Micr. Soc.* iii.; id. *Ann. Nat. Hist.* 1856, 333; Van d. Hoeven, *Zoolog.*, and Leuckart, *Nachträge*; Carpent. *The Microscope*; Slack, *Marvels, &c.* 1861; Pritchard, *Infusoria*; Schmarda, *Neue Ro-*

tatoria, 1861; Weisse, *Floscularia ornata*, *Sieb. and Köll. Zeitsch.* xiv. p. 107 (Plate); Mecznikow, *Sieb. and Köll. Journ.* 1865; *Qu. Mic. Jn.* 1866, pp. 34 & 240; Claparède, *Ann. Nat. Hist.* 1868, i. p. 309; Schloch, *Die Räderthiere*, 1869; Cubitt, *M. M. Jn.* 1871, vi. 168, 1872, viii. 5; Hudson, *M. M. Jn.* 1872.

ROT'IFER, Cuv.—A genus of Rotatoria, of the family Philodinæa.

Char. Eyes two, situated upon the proboscis; foot furnished with lateral horn-like processes, and with two terminal toes, giving its end a bifurcate appearance.

R. vulgaris (Pl. 35. fig. 23). Body fusiform, white, gradually attenuated towards the foot. Aquatic; length 1-48 to 1-24″.

This is one of the commonest of the Rotatoria, and has long been known as a favourite microscopic object under the popular name of the wheel-animalcule. The anterior and upper part of the body terminates in a proboscis, ciliated at the end, and upon which the eyes are placed; the two rounded lobes of the rotatory organ are placed laterally. Behind, and at the root of the proboscis, is the calcar.

In *R. citrinus*, the middle of the body is yellowish, the horns of the foot long, and the eyes round. In *R. macrurus* the body is suddenly narrowed into a long foot. In *R. tardus* the body is gradually attenuated, but somewhat deeply constricted into segments. The species are all aquatic.

Bibl. Ehr. *Infus.* p. 484; Pritchard, *Infus.*; Grenacher, *M. Mic. Jn.* 1870, p. 44.

ROTIF'ERA. See Rotatoria.

RUBEFACTION of Water. See Water.

RUCKE'RIA.—A genus of Compositæ. The pericarp possesses Hairs of an interesting structure.

Bibl. Decaisne, *Ann. N. Hist.* vi. p. 257 (trans. from *Ann. Sc. Nat.* 2 sér. xii. p. 251).

RUEL'LIA.—A genus of Acanthaceous Plants. The testa of the seed of *Ruellia formosa* exhibits a peculiar kind of Hair (Pl. 21. fig. 21).

RUST of Plants. See Blight.

RUTILA'RIA, Grev.—A genus of Diatomaceæ.

Bibl. Grev. *Mic. Trans.* 1866, p. 124.

RYE.—The grain of *Secale cereale*. See Starch.

RYLAND'SIA, Grev.—A genus of Diatomaceæ.

Bibl. Greville (Plate), *Qu. Mic. Jn.* 1861, pp. 39 & 67.

RYTIPHLŒ'A, Ag.—A genus of Rhodomelaceæ (Florideous Algæ), containing four British species, mostly common, having pinnately branched, filiform or compressed fronds, transversely striate and reticulated; the articulate axis is composed of a circle of large elongated tubular cells surrounding a central cell, the whole enclosed by a kind of rind of several layers of small coloured cells. Colour mostly dull-red or brown. Fronds from 2″ to 4″ or 6″ high. The *ceramidia* occur scattered on the ramules of some plants; the *antheridia* tufted in the same situations on others; and *tetraspores* (tetrahedral) occur imbedded in a double row in *stichidia*, borne on distinct plants.

Bibl. Harvey, *Brit. Mar. Alg.* p. 80, pl. 11 D; Grev. *Alg. Brit.* pl. 13; Derbès and Solier, *Ann. des Sc. Nat.* 3 sér. xvi. p. 275, pl. 35. figs. 11 & 12; Thuret, *ibid.* 4 sér. iii. p. 20.

S.

SABEL'LA. — A genus of Tubicola (Annelida), in which the tube is composed of grains of sand or mud.

SACCAMI'NA, Sars. See Lituolida.

SACCOG'YNA. — A genus of Jungermannieæ (Hepaticæ) founded on the *Jungermannia viticulosa* of Linnæus; it is remarkable on account of the subterraneous fleshy perianth, in which character and in habit it is allied to *Calypogeia*. It is found among mosses, especially in alpine districts.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 121; *Brit. Jung.* pl. 60; Ekart, *Syn. Jung.* pl. 1. fig. 6; Endlicher, *Gen. Plant.* Supp. 1. No. 472-23.

SAC'CULUS, Gosse.—A genus of Rotatoria, of the family Ichthydina.

Char. Eye single, frontal; body free from hairs, and without a foot; rotatory organ a simple wreath; alimentary canal very large; jaws set far forward, apparently consisting of two delicate unequal lateral pieces, and a slender central portion, very evanescent; eggs attached behind after deposition.

S. viridis. Length 1-150″; aquatic.

Bibl. Gosse, *Ann. Nat. Hist.* 1851, viii. 198.

SAGE'DIA, Fries.—A genus of Endocarpeæ (Angiocarpous Lichens), consisting of a few anomalous plants, closely related to *Endocarpon* and *Verrucaria*.

Bibl. Leighton, *Brit. Ang. Lich.* p. 21.

SAGO.—Farinas obtained from a variety of tropical plants are known by this name; but the true East-Indian sagoes are ex-

tracted from the central part of the trunks of Palm-trees belonging to the genus *Sagus*, natives of the Moluccas. In Pl. 37. fig. 23, is figured the starch of a sago obtained from the Museum at Kew; but it is uncertain whether this is the produce of a *Sagus*. Its grains resemble those of some East-Indian Arrow-roots (Pl. 37. fig. 18). See STARCH.

SAGRI'NA, D'Orb. (SAGRAINA, Reuss). See UVIGERINA.

SALA'CIA, Lamx.—A genus of Lafoëidæ (Hydroida).

Char. Stem erect, composed of aggregated tubes, branching, rooted. Hydrothecæ cylindrical, sessile, without operculum, adnate for the greater part of their length, disposed on all sides of stem and branches in a regular and equidistant longitudinal series. Gonothecæ scattered on the stem and branches; gonophores unknown. Polypites long, cylindrical, with a conical proboscis.

S. abietina. Deep water off Northumberland coast.

BIBL. Hincks, *Brit. Hyd. Zooph.* p. 211.

SALICINE.—The alkaloid of the willow and poplar.

The so-called circular crystals of this substance (Pl. 31. fig. 9) form a beautiful polarizing object. The largest crystals are obtained by fusion.

SALICORNA'RIA, Cuv.—A genus of Infundibulate Cheilostomatous Polyzoa.

Char. Surface divided into rhomboidal or hexagonal spaces by ridges surrounding the cells; avicularia disposed irregularly. One species:

S. farciminoides. On old shells, &c. from deep water, not uncommon.

BIBL. Johnston, *Brit. Zooph.* 355; Busk, *Cat. of Mar. Polyz. (Brit. Mus.)* 16; Heller, *Verhandl. zool.-bot. Gesellsch. in Wien*, Bd. xvii. 1867, p. 85.

SALICORNARI'ADÆ.—A family of Infundibulate Cheilostomatous Polyzoa.

Char. Polypidom erect, branched, jointed; branches cylindrical, dichotomous, with the cells on all sides. One genus:

SALICORNARIA.

SALIVA and SALIVARY GLANDS.—The glands which secrete the saliva are the parotids, the submaxillary, and the sublingual. Each consists of a single excretory duct, which branches repeatedly towards the body of the gland, so as to subdivide it into a multitude of lobes and lobules, which are connected with connective tissue and nucleated fibres resembling unstriped muscular fibres, and invested by a strong fibrous capsule. Numerous nerves and blood-vessels supply the lobules or alveoli, which have externally a limiting membrane and internally an epithelium, which is continuous with that of the ramifying tubular ducts.

The limiting membrane, or membrana propria, is homogeneous and continuous, and not reticulate; but it is perforated by the nerves which supply the cell-structure within, and it is connected externally with numerous multi- or quadripolar cells, which Kölliker considered to be connective-tissue cells, and Pflüger pronounces to be ganglion-cells. The columnar epithelial cells, supported by the limiting membrane, form a single layer, which limits a central canal; and each cell is closely applied to those in contact with it laterally, so that the whole is more or less tessellated in appearance. The cells are nucleated, and the pale single spherical nucleus of each cell lies close to the limiting membrane. Pflüger asserts, and Kölliker denies, that these nuclei often give off an extremely delicate fibre, which penetrates that surface of the salivary cell which is in contact with the membrane. The cells contain granules and tenacious fluid protoplasm (and of course to some observers this is even arranged in fine fibrils).

The alveoli or lobules are closely compressed and flattened against each other, and are bound down by the connective tissue and nuclear fibres; and an exceedingly small quantity intervenes between the different grape-like masses, which all enter into one particular ramification of the duct; but there is much of it between the lobules of neighbouring tubes. Minute fissures exist where the secondary and tertiary groups of lobules belonging to one ramifying duct are united together, and the connective tissue which bounds these openings is lined with an indistinct epithelium. They are probably lymphatics. The minute capillaries enter the connective tissue; but their method of termination has not been satisfactorily determined. The nerves pass in through the tissue to reach the limiting membrane of each alveolus; but what then becomes of them is a matter of great dispute, owing to the apparently necessary alteration of the normal structures by such reagents as chromic acid solution ($\frac{1}{50}$ per cent.), osmic acid solution, alcohol, and glycerine, before the termination of the nerve can be traced under a

power of some 500 diameters. Pflüger states that, besides the medullated nerves, there are three kinds of pale nerves, and there are also the ganglion multipolar cells already noticed. The first kind of pale nerve consists of extremely transparent fibres, presenting the characters of axis-cylinders invested with a nucleated sheath; they become fusiform here and there, and when not acted upon by reagents, possess the appearance of naked axis-cylinders. The second kind are called gelatinous fibres, and consist of bands of finely granular protoplasm lying in a sheath of nucleated connective tissue; they may be observed to be continuous with the ganglion-cells. The third kind consists of bundles of fine fibrils in a sheath with oval nuclei; they resemble the nerve-fibres of Remak. The medullated fibres have excessively delicate sheaths, and are prone to form varicosities; they divide and subdivide, so that almost feathery medullated fibres lie between the alveoli, and give off branches in all directions. Some observers do not hesitate to state that the ultimate fibrils penetrate the limiting membrane, and become connected organically with the epithelium cells, which, moreover, they say have delicate fibrillar processes on their bases. Moreover, the fibres and terminations of the multipolar ganglion-cells which are situated just outside the limiting membrane are also stated to merge into the epithelial cell-wall.

The tubular part of the glands is lined with cylindrical epithelium, which is elongated on the smaller ducts and less so near the excretory duct. The cells are nucleated, and have a stout cell-membrane, which, according to some observers, is fibrillar close to the investing membrane of the duct, especially when iodized serum has been used (Pl. 1. fig. 5).

The proper excretory ducts are lined with an epithelium consisting of short cylindrical cells, and the wall is strengthened by fibres of connective tissue with elastic fibres and unstriped muscular fibres. The saliva in health contains no morphological elements, but forms a transparent homogeneous fluid; but under great mechanical irritation, and according to Pflüger, it contains epithelial cells, with adherent medullary nerve-fibres and connective tissue. Usually, simple catarrh or some trifling irritation produces the so-called salivary corpuscles, granular nucleated cells, and granular cloudy mucus.

Bibl. Todd and Bowman, *Physiology*; Ward, *On Salivary Glands*, *Todd's Cyclop.*; Gianuzzi, *Ber. d. k. Sächs. Ges. d. Wiss.* Nov. 1866; Heidenheim, *Stud. d. Physiolog. Inst. zu Breslau*, t. iv. 1868; Kölliker, *Mik. Anat.*; Pflüger, *in Stricker's Hum. & Comp. Hist.* i. p. 423; Frey, *Handb. d. Hist. u. Histochemie*, p. 455; Wright, *On Saliva*, London, 1842; Bernard, *Leçons*, Paris, 1858.

SALPI'NA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes single, cervical; foot forked; carapace closed on the ventral surface, and furnished with spines or horns at the ends. Aquatic.

The carapace resembles a three-sided box with convex sides, flat and closed beneath, and often scabrous.

S. redunca (Pl. 35. fig. 24). Carapace with two curved horns in front upon the ventral surface, smooth, posterior end with three horns; dorsum cleft, gaping. Length of carapace 1-216 to 1-144″.

Five other species.

Bibl. Ehr. *Infus.* p. 469; Pritchard, *Infus.*

SALPIN'GIA, Coppin.—A genus of Infundibulate Cheilostomatous Polyzoa, of the family Eucratiadæ.

Char. Erect, branched; cells elongate, with spines and trumpet-shaped processes; orifice lateral. One species:

S. Hassalii. On filamentous *fuci*; rare.

Bibl. Coppin, *Ann. Nat. Hist.* 1848, ii. p. 273.

SALTS. See Crystals.

SAL'VIA, L.—An extensive genus of Flowering plants of the Nat. Ord. Labiatæ, including common sage, and many species cultivated for the beauty of their flowers. They are interesting to the microscopist both on account of the glandular hairs, containing the essential oils, and the spiral-fibrous structures found in the Hairs of the pericarp (Pl. 21. fig. 23) and the hairs of the stigma.

SALVIN'IA, Mich.—A genus of Marsileaceæ, growing floating on the surface of stagnant water (not British).

The fructification appears to resemble that of *Marsilea* and *Pilularia*, except that the antheridia and sporangia are contained in separate sacs, and also attached to a sort of central cellular stroma. The prothallium of *Salvinia* produces several archegonia, and not one only.

Bibl. Berkeley, *Man. of Bot.* p. 350. See Marsileaceæ and Pilularia.

SAND, Brain-.—Brain-sand, or the acervulus cerebri, is found in the pineal gland and the choroid plexus, sometimes also in the pia mater, the arachnoid membrane, and the walls of the ventricles.

Fig. 632.

Brain-sand from the pineal gland, in bundles of areolar tissue.

Magn. 350 diams.

It consists of single, or aggregated and nodular, rounded, dark bodies, 1-2500 to 1-200″ in diameter, sometimes also forming club-shaped, cylindrical, or reticular masses. Chemically it is principally composed of carbonate and phosphate of lime, and, like other concretions, leaves an organic cast of the original form, after the salts have been removed by a dilute acid.

Bibl. Kölliker, *Mikr. Anat.* ii.

SAND, Sea-. — This often contains interesting microscopic objects, as Foraminifera, spicules of sponges, minute shells of the Mollusca or their fragments, portions of the skeleton of the Echinodermata, &c.

The various bodies may be separated from the washed and dried sand with a mounted bristle.

The sand or powder which may be separated by pressing or shaking newly imported sponges, and which is sometimes called sponge-sand, is very rich in the above organic bodies, especially the Foraminifera.

SAP.—A name vaguely applied to the watery juices contained in living plants. Sap flowing from wounds may contain various organized substances, such as starch-granules, chlorophyll-globules, protoplasm, and also raphides; but it cannot be said to have any proper microscopic characters.

SAPROLEG'NIA, Nees. See Achlya.

SAPROLEGNIE'Æ. See Confervoideæ. See also Pringsh. *Jahrb. wiss. Bot.* 1857 and 1873.

SARACENA'RIA, Defrance.—A short, thick, triangular modification of *Cristellaria*. Recent and fossil.

Bibl. Parker and Jones, *Ann. Nat. Hist.* ser. 3. xii. 217.

SAR'CINA, Goodsir.—A curious organism, placed provisionally among the Palmellaceæ (Confervoid Algæ) from considerations relating to its apparent structure, but which in its habitat and general characters would appear more nearly related to the Fungi. *Sarcina ventriculi* (Pl. 3. fig. 5 *a* and *b*) is a body found sometimes in great abundance in vomited contents of the stomach of the human subject, also in the stomach after death, where no disorder had appeared during life; in the lung, blood, urine, fæces, in the pus of pulmonary abscess, &c.; it has also been found in the stomach of the rabbit. It ordinarily consists of minute cubical, oblong, or even irregular masses, of considerable consistence, composed of four, eight, sixteen, sixty-four, or more squarish cells contained in a tough transparent frond, apparently composed of the cell-membranes of these cells. The cells are always most closely connected in groups of four, which stand a little more apart from each other in the secondary groups of sixteen; these again have a stronger line of demarcation between them when they are collected into tertiary groups of sixty-four (Pl. 3. fig. 5 *a*, *b*). The size of the primary cells (nuclei of Ch. Robin) appears to vary slightly; we find their diameter about 1-16,000″; they have a slight brownish tint, which imparts a colour to the whole mass. Iodine colours the fronds brown; alcohol contracts them a little. Nitric acid does not dissolve them, even when heat is applied. Alkalies cause the fronds to break up into their constituent components. The plant appears to increase by the division of the contents of its ultimate cells into four and the formation of a new membrane around each portion, the groups remaining attached a longer or shorter time according to circumstances. The history of this remarkable production requires further elucidation; it is evidently not connected with any special derangement of the stomach, as was formerly supposed; and its occurrence is now known to be much more common than was at one time imagined. Mr. Berkeley has in vain tried to get it to germinate in sugar and water.

Ch. Robin places *Sarcina* in Meyen's genus *Merismopædia*; but from its habit and general character, *Sarcina* would appear to be rather referable to the Fungi.

Mr. H. C. Stephens has described what he regards as a second species of *Sarcina*, which he found upon calcined ox-bones, giving them a red colour. The cells of this are about half the size of those of *S. ventriculi*.

Bibl. Goodsir, *Edinb. Med. and Surg. Journ.* 1842, p. 430; *Anat. and Path. Obs.* Edinb. 1845, pl. 8. figs. 1 & 3; Busk, *Mic. Journ.* 1843; Nägeli, *Einz. Alg.* p. 2; Ch. Robin, *Végétaux Parasit.* 2nd edit. p. 331; Bennett, *Lectures on Clin. Med.* 1851, p. 214; Rossmann, *Flora*, 1857, p. 641; Stephens, *Ann. Nat. Hist.* 2 ser. xx. p. 514.

SARCOCH'ITUM, Hass.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Alcyonidiadæ.

Char. Encrusting, covered with perforate prominences in which the cells are immersed; ova scattered singly throughout. One species:

S. polyoum. On *Fucus serratus.*

Bibl. Hassall, *Ann. Nat. Hist.* 1851, vii. 484.

SARCODE.—A term applied by Dujardin to the gelatinous, homogeneous, diaphanous proteine substance occurring abundantly in very young animals, the larvæ of insects, embryos of the Vertebrata, worms, zoophytes, &c. It is synonymous with protoplasm; but it is employed to represent all the soft structures of the Protozoa, and therefore includes something more than that undifferentiated substance. It appears to constitute the whole of some of the lower animals, as the *Amœbæ*. It may be readily studied when exuding from around the body of the intestinal parenchymatous worms, as the *Distoma*, *Cysticercus*, *Tænia*, &c., or almost any of the Infusoria, placed alive in water between two plates of glass. In the course of a short time, the bodies of the animals are seen to be bordered with a row of projecting diaphanous globules (Pl. 25. fig. 2 *a*), frequently more or less pressed together, which after a time become separated and float in the liquid, especially if it be shaken. Spherical cavities or vacuoles are soon perceptible in these globules of sarcode (Pl. 25. fig. 2 *b*), the nature of which is readily determined by comparing the refraction of the light at their circumference with that at the circumference of the globules themselves; for on elevating the object-glass, the centre of the vacuoles becomes darker, and the centre of the globules becomes brighter; whilst on approximating the object-glass, the reverse takes place. The spontaneously produced cavities continue to enlarge and increase in numbers, until some of the globules appear perforated in all directions. Ultimately the globules become so altered by the action of the water, that they form a thin granular or wrinkled layer, resembling coagulated albumen.

The protoplasm of vegetable cells appears to correspond to the sarcode of animal structures. In certain cells it exists in two forms as regards density, the outer portion being firmer than the inner; or it may become entirely liquid. In many of the lower organisms, and probably most cells in their youngest state, it is glutinous, and in the former permanently remains so.

When existing in cells and the lowest animals, it appears to constitute the essential part of their structure, and is capable of performing all the functions carried on by the tissues of the higher or more perfect organisms. It also appears that the cell-theory, in so far as it attributes the principal importance to the cell-wall, is founded upon error—the cell-wall merely forming a protection to the sarcode or primordial utricle of plants, and the sarcode or protoplast as it might be called of animals, enabling them to carry on their essential functions uninterrupted by surrounding influences.

Bibl. Dujardin, *Infus.* p. 35.

SARCOLEM'MA. See Muscle.

SARCOM'ATA.—These are tumours usually known as fibro-plastic, fibro-nucleated, recurrent fibroid, and myeloid. They consist of connective tissue, which throughout its growth retains its embryonic type; and the kinds depend upon the size and configuration of the cells and the nature of the intercellular substance. The cells which constitute nearly the whole of the growth, consist for the most part of protoplasm, including a nucleus, but not included by a cell-wall; and they may be round, fusiform, and myeloid. The round cells are in some instances undistinguishable from lymph-cells or white blood-corpuscles; others resemble granulation-cells. The fusiform or fibroplastic cells are sometimes stellate; they are granular and have a long oval nucleus, and they resemble the cells of granulation or embryonic tissue, which is in process ot forming mature connective tissue. The myeloid or mother cells are larger than the preceding kinds; they are irregular in shape, and mostly spherical with offshoots. They are finely granular, and contain several nuclei and nucleoli. The nuclei may be exceedingly numerous, one cell containing as many as thirty. An intercellular substance exists in all sarcomata, although it is small in quantity, the cells lying in nearly close

apposition. It may be perfectly fluid and homogeneous, or firmer and granular or less frequent, more or less fibrillated. The blood-vessels are numerous, and their walls consist of embryonic tissue. This growth takes place by the multiplication of their own elements, and is either central or peripheral; and they undergo fatty degeneration, cystic growth, ossification, and mucoid degeneration. These secondary changes impart their respective characters to growths which are known by the terms osteoid, sarcoma, melanotic sarcoma, and cystic sarcoma. The so-called malignancy of these tumours depends upon the rapid cell-growth and increasing vascularity of the structures. They form most important and interesting microscopic objects. See TUMOURS.

BIBL. Virchow, *Virch. Archiv*, 1848, i. pp. 195 & 470; Reinhardt, *Path. Anat. Unters.* 1852, p. 122; Paget, *Surgical Pathology*, 1853, ii. pp. 151, 156, 212; Billroth, *Virchow Archiv*, 1856, ix. p. 172, xviii. p. 82; Volkmann, *Virch. Archiv*, 1857, xii. p. 27; Reindfleisch, *Path. Hist.* (*Syd. Soc.* tr. Baxter) vol. i. p. 146; Green, *Path. & Morb. Anat.* p. 109.

SARCOP'TES, Latr.—A genus of Arachnida, of the order Acarina, and family Acarea.

S. scabiei (*Acarus scabiei*) (Pl. 2. fig. 16). The itch-insect of man.

Body soft, white, oval-oblong or rounded; ventral surface with transverse and undulating rugæ; dorsal surface with marginal irregularly concentric rugæ, the central space with numerous short and conical papillæ and stouter but short protuberances or spines arising from an annular base; at the sides and upon the surface of the body are also scattered setæ. Head small, somewhat narrowed in front; mandibles toothed. Anterior two pairs of legs separated from the posterior by a considerable interval; legs short, the anterior two pairs with acetabula or adhesion-disks and five-jointed, the posterior three-jointed, the last joint terminated by a long seta and without acetabula. Length of female 1-100 to 1-75''.

The females burrow in the skin, in which the oval eggs, 1-120'' in length, are laid; these are hatched in about ten days, and the young have only six legs.

Male only about half the size of the female, and with acetabula to the hindermost pair of legs.

There is no question that the irritation produced by these mites and their ova is the cause of the itch.

They should be searched for at the bottom of one of the burrows, which are often visible to the naked eye; the ova are frequently present in the pustules. They are most easily found by examining the skin with a power of fifty to seventy diameters, attached to a firm but movable arm, and with the aid of a good bull's-eye condenser.

The entire animals may be preserved in glycerine or solution of chloride of calcium; the parts of the mouth should be dried and mounted in Canada balsam.

Other imperfectly examined or doubtful species occur upon animals, as the dromedary, the chamois, the dog, sheep, rabbit, &c.

See DEMODEX and PSOROPTES.

BIBL. Bourguignon, *Traité, &c., de la Gale* (abstract in *Ed. Monthly Journ.* 1852, lx.); Gervais, *Walckenaer's Insect. Aptères*, iii. 268, and *Ann. des Sc. Nat.* xv. 9; Hering, *D. Krätzmilben. d. Thiere*, *Nov. Act. Nat. Cur.* xviii. 573; Dugès, *Ann. des Sc. Nat.* 2 sér. iii. 245; Wedl, *Pathol. Histolog.* 798.

SARCOS'CYPHUS, Corda.—A genus of Jungermannieæ (Hepaticæ). *S. Ehrharti* (*Jung. emarginata*, Ehrh.) is a remarkable species, of dark purple, almost black colour,

Fig. 624.

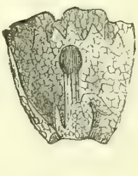
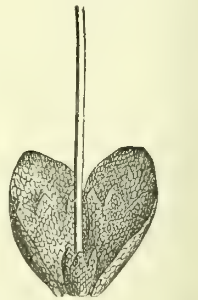


Fig. 625.



Sarcoscyphus Ehrharti.

Fig. 624. Perichæte and perigone opened, showing the young sporange emerging from the epigone. Magnified 25 diameters.

Fig. 625. Perichæte and perigone opened, showing the base of the seta surrounded by the epigone. Magnified 10 diameters.

growing frequently in wet places, on rocks of mountainous districts.

BIBL. Hook. *Brit. Flor.* ii. pt. 2. p. 114; *Brit. Jung.* pl. 27; Ekart, *Synops. Jung.* pl. 7. fig. 56, and pl. 13. fig. 113; Endlicher, *Gen. Plant.* Supp. i. nos. 474–1.

SARGAS'SUM, Ag.—A genus of Fucaceæ (Fucoid Algæ), gulf-weeds, known

from the allied sea-weeds by its stalked globular air-vessels. The receptacles are small, linear, and mostly clustered at the base of branches, and pierced by numerous pores leading to *conceptacles* containing spore-sacs and clusters of antheridia (see FUCACEÆ).

BIBL. Harvey, *Brit. Mar. Alg.* p. 14, pl. 1 A; Greville, *Alg. Brit.* pl. 1.

SCALARIFORM VESSELS. See SPIRAL VESSELS.

SCALES OF FISHES. — These bodies were formerly regarded as epidermic formations, analogous to the nails, &c. of the higher animals, which later observations have shown not to be the case.

Each scale is contained in a distinct sac of the skin or cutis, covered externally with its pigment-layer and epidermis. The cutis itself consists of interlacing fibres of areolar tissue with formative cells. The pigment-layer is composed of elegant pigment-cells with long processes. Immediately above the upper surface of the scales lies a very fine membrane, distinct from the cutis, in which the impressions of the irregularities of surface existing upon the scales are visible.

In some fishes, as the eel, the scales do not project beyond the surface; hence the eel is commonly supposed to possess no scales. They are easily seen, however, in a dried piece of the skin, mounted in balsam, covered by the skin with its pigment-cells (Pl. 17. fig. 19), the whole forming a very beautiful object.

In many of the common cycloid fishes, as the roach, dace, &c., the scales project posteriorly from the surface, carrying before them the thinner and closely applied outer layer of the cutaneous sac, whilst the anterior portion of the sac extends into or is formed by the under portion of the cutis. In these fishes also, the portion of the cutis situated beneath the posterior projecting portion of the scales contains a large number of very thin and minute crystals, to which the silvery lustre of the skin is owing, and which often exhibit very beautifully the colours of thin plates.

The signification of the various parts of structure of the scales has not been satisfactorily determined; hence we must confine our remarks to simply pointing out the structural peculiarities.

Most scales consist of two portions,—an under, composed of numerous layers made up of very fine fibres taking various directions, and best seen by scraping away the upper portion of the scale after maceration in dilute acid (Pl. 17. fig. 11 *a*). The upper portion consists of concentric plates, the margins of which give rise to the concentric lines so frequently seen in the scales (Pl. 17. figs. 6, 10, 22, 23, &c.). These lines correspond to the margins of the layers, and often present a nodular or crenate appearance (Pl. 17. fig. 11 *b*); and towards the middle of the scales they are frequently interrupted and irregularly curved (Pl. 17. fig. 11 *c*). The substance of the upper portion appears to be structureless.

In a transverse section, the projecting margins of the laminæ belonging to the upper portion of the scale are seen as so many teeth (Pl. 17. fig. 12).

Many scales also exhibit radiating lines (Pl. 17. fig. 23), corresponding to furrows in the upper portion of the scales; these are sometimes closed above, so as to form tubes, and have been regarded as nutritive canals.

Near the centre of some scales, as those of the perch, are numerous rounded corpuscles or solid bodies, imbedded in the substance of the upper portion of the scales (Pl. 17. figs. 6 *a* & 7). At the posterior portion of the same scales are often seen spine-like processes (Pl. 17. figs. 6 *b* & 9), with rounded or angular bodies, resembling the last in appearance, arranged in rows at their bases (Pl. 17. fig. 8).

The scales of the eel appear to be principally composed of similar bodies, differing only in form, and arranged in concentric rows (Pl. 17. figs. 20 & 20 *a*). They are solid, impregnated throughout with calcareous matter, which is left after incinerating the scales, retaining the original form of the bodies (Pl. 17. fig. 21).

In the scales of some fishes, particularly those of extinct genera and species, lacunæ and canaliculi resembling those of bone (Pl. 17. fig. 1 *c*), with Haversian canals, are met with. A vitreous or enamel-like layer, having the structure of dentine, is also met with in the form of an external coating.

The structure of the spines or spine-like scales of the skate is curious. The larger of them consist of a button-like base, surmounted by a sharp process (Pl. 17. fig. 3). The outer and lower part of the base is opaque-white, and consists of an imperfectly fibrous tissue with large areolæ (Pl. 17. fig. 37). The spine is hollow, the cavity being continuous with that of a rounded

body, partly immersed in the white substance (Pl. 17. fig. 3 *a*). The cavity is filled with a pulp, consisting of lax areolar tissue with minute cells; whilst its walls are composed of a hard substance traversed by branched canals resembling those of dentine (Pl. 17. fig. 4). The substance of the smaller spines (Pl. 17. fig. 2) exhibits the same dentinous structure (fig. 5).

Pl. 17. fig. 10 represents one of a longitudinal row of scales extending along the middle of the side of the body of most fishes, and traversed by a tube (*a*), formerly supposed to give exit to the mucous secretion of the surface, which view has lately been thrown into doubt. The tubes are visible to the naked eye, and produce the lateral line, as it is called.

The scales of fishes contain a large amount of inorganic matter, composed principally of phosphate of lime, but mixed with the carbonate. The organic basis consists of a cartilaginous substance.

Some years since, M. Agassiz founded a classification of fishes upon the structure of the scales, having found that with differences in the scales, other great and important distinctions were in harmony. The system has been found of eminent survice to the geologist; although later researches have shown that scales presenting the characteristics of those belonging to fishes of different orders in this system have been found upon the same fish.

The arrangement was as follows:—

Scales enamelled.

Ord. 1. Ganoid fishes. Those the skin of which is regularly covered with angular thick scales, composed internally of bone, and externally of enamel. Most of the species are fossil, the sturgeon and bony pike being recent.

Ord. 2. Placoid fishes. Skin covered irregularly with large or small plates or points of enamel. Includes all the cartilaginous fishes of Cuvier, except the sturgeon; as examples may be mentioned the sharks and rays. Many are fossil.

Scales not enamelled.

Ord. 3. Ctenoid fishes. Scales horny or bony, serrated or spinous at the posterior margin. Contains the perch and many other existing species, but few fossil.

Ord. 4. Cycloid fishes. Scales smooth, horny or bony, entire at the posterior margin; as the salmon, herring, roach, and most of our edible and freshwater fishes.

Most of the fossil fishes belong to the first two orders, and most of the recent to the third and fourth.

Bibl. Agassiz, *Rech. sur les poissons fossiles, Ann. des Sc. Nat.* 2 sér. 14; Mandl, *Ann. des Sc. Nat.* 2 sér. xi. xii. xiii. & xiv.; Reade, *Ann. Nat. Hist.* 1838, ii. 191; Müller, *Wiegm. Archiv,* 1843, 298; Vogt, *Zoolog. Briefe,* ii.; Williamson, *Phil. Trans.* 1849, p. 435, & 1851; Salbey, *Structure and Growth of Scales of Fish, Ann. Nat. Hist.* 1870, v. p. 67.

SCALES of Insects.—The fine dust which adheres so readily to the fingers on handling a butterfly or moth consists of a number of microscopic flattened bodies, called scales or feathers, upon which the beautiful colours and opacity of the wings depend, the membranous wing itself being transparent and colourless.

These scales have always been favourite microscopic objects, both on account of the beauty and variety of their forms, and the curious markings found upon them. The manner in which they are attached is best examined in the wing of a butterfly. Each has a narrow portion at its base, forming a pedicle or stalk. The stalks are implanted into small and short tubes or cups (Pl. 27. fig. 23 *b*), denominated the squamuliferous tubes, the orifices of which are directed backwards. Around the points of attachment of the cups to the wings, the surface exhibits a number of irregularly radiating rugæ or folds of the upper membrane of the wing (Pl. 27. fig. 26). The cups are arranged in more or less regular transverse rows. Each scale is composed of two superficial laminæ, enclosing a central lamina of structureless membrane, the surface of which is highly polished.

The scales are variable in form, both in different insects and in different parts of the same insect, being oval, oblong, cordate, obcordate, or cuneate, &c. (Pls. 1 & 27); sometimes they are filiform or capillary (Pl. 27. fig. 27). Their free end is rounded, truncate, toothed, or terminated by a number of hair-like processes; and they are arranged like the tiles of a roof, overlapping each other (Pl. 27. fig. 26).

The interesting markings seen upon the scales vary considerably in different insects.

The most common, as seen by transmitted light, are longitudinal, simple, continuous, parallel or slightly radiating dark striæ or lines (Pl. 1. figs. 6, 7, 8, 9 *a*). These are met with upon the scales of nearly all butterflies and many other insects. In some in-

sects the striæ are not simple and continuous, but are made up of rows of smaller striæ in twos or threes meeting at an angle (Pl. 27. figs. 28 *b*, 30, & 31). In others they are composed of a number of bead-like dots, or are interrupted, still preserving their general longitudinal direction (Pl. 27. fig. 24); or they are slightly undulate or irregular, and give off short lateral branches (Pl. 27. figs. 23 *a* & 29). In others, again, they present dilatations in certain parts of their course (Pl. 27. figs. 20 & 21).

These longitudinal striæ consist of elevations or ridges upon the surface, probably representing folds of the upper layer or membrane of the scale. They often project slightly from the free end of the scale (Pl. 27. figs. 3 & 22); and when moistened bubbles of air may not unfrequently be found imprisoned between the surface of the scale and the cover, which, being confined between two of the ridges, assume an oblong form. They sometimes contain air, which may be displaced by liquid (Pl. 27. fig. 21). We have never been able to detect tracheæ in these folds or in the scales. A minute conical point or spine sometimes occurs in each of the dilatations when present (Pl. 27. fig. 20 *a*).

In the scales of *Podura* (Pl. 1. fig. 12), the striæ consist of longitudinal rows of minute bodies like notes of exclamation (!); they are rods which are cylindrical and narrow at the base and often constricted near the summit. Royston Pigott has seen circular markings between and about the origin of the rods in crushed specimens.

In addition to the longitudinal striæ, on most scales, especially when examined by unilateral oblique light, are seen a number of minute transverse striæ (Pl. 1. figs. 7 & 9 *a*). These are neither indications of ridges nor depressions, but arise from the existence of a number of pigment-granules situated between the two layers of the scale; and the appearance of striæ has the same origin as that in the case of the valves of the Diatomaceæ. This point is best examined in brown or other dark-coloured scales. If perfectly direct (*i. e.* not oblique) light be transmitted through one of these scales, the transverse striæ vanish, their place being occupied by the distinct and isolated granules of pigment (Pl. 1. fig. 9 *b*); the scale should also be immersed in balsam or liquid, to diminish the effects of the refraction arising from the inequalities of the surface of the scale. On then transmitting unilateral oblique light through the scale, the appearance of transverse striæ may be easily produced.

The colours of the scales of insects arise partly from iridescence, partly from the presence of pigment; in general, the brilliant colours depending upon the former, and the more sombre hues upon the latter. The darkness of the longitudinal striæ is caused by refraction; for scales containing no pigment appear perfectly white by reflected light, although the striæ may be very dark.

Upon certain scales, other irregular, more or less transverse curved striæ exist (Pl. 27. figs. 3 & 22); these appear to consist of wrinklings or folds of the under membrane of the scale.

In examining the scales of insects, they should be viewed both in the dry state and immersed in water or oil of turpentine, and both by transmitted and reflected light. When the insects are pressed against the slide to remove the scales, a number of globules of oil adhere simultaneously to the slide; and when the cover is applied, the scales often become partially or entirely covered with the oily matter, producing an appearance as if the upper layer of the scale were removed, and rendering the markings so pale and indistinct as to be apparently absent. The appearance of transverse striæ is best produced by turning the mirror to one side, so as to reflect unilateral light.

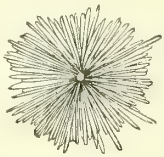
A brief notice of some interesting insects in respect to the structure of their scales is given under the individual heads, as CURCULIO, LEPISMA, MORPHO, PODURA, POLYOMMATUS, PONTIA, TINEA, &c.

See also TEST-OBJECTS.

BIBL. Westwood, *Introduction, &c.*, and *British Butterflies*; Deschamps, *Ann. des Sc. Nat.* 2 sér. iii. p. 111; Bowerbank, *Entomol. Mag.* No. 23. p. 304; Duj. *Obs. au Micros.*; Ratzeburg, *Die Forst-Insekten*; Siebold, *Vergleich. Anat.*; Pigott and M'Intire, *M. M. J.* 1870, iv. p. 321; *M. M. J.* 1871, v. p. 3; Watson, *M. M. J.* ii. pp. 73 and 314; Hogg, *M. M. J.* 1871, vi. p. 192; Anthony, *M. M. J.* 1872, vii. pp. 1 and 250; Woodward and Royston Pigott, *Qu. Mic. Jn.* passim, and *Mo. Mic. Jn.* March 1873; Carpenter, *The Microscope*; M'Intire, *Mo. Mic. Jn.* iii. p. 1; Maddox, *M. M. J.* 1871, v. p. 33; Woodward, v. p. 149; Beck, *Qu. M. Jn.* 1864, p. 2; *Mo. Mic. Jn.* iv. p. 252; Wonfor, *Qu. Mic. Jn.* 1868, p. 80; Slack, *Mo. Mic. Jn.* vii. p. 48; Pigott and Beaumont, *Proc. Roy. Soc.* 1873, p. 222; Wenham, *Mo. Mic. Jn.* 1874, p. 75.

SCALES OF PLANTS.—Under the head of HAIRS, mention has been made of scales (*lepides*) occurring on the epidermis of plants. They consist of flat, usually more or less circular plates of cellular tissue, the cells presenting a radiated arrangement from the centre, by which they are ordinarily attached; the margins are usually toothed or fringed more or less regularly by the prolongation of the free ends of the cells. They are closely related to stellate hairs, such as those of ivy, of *Deutzia* (Pl. 21. figs. 26, 27), &c., and may be regarded as more highly developed forms of these. They are particularly remarkable on the epidermis of certain plants which exhibit a kind of scurfy surface, for example the Eleagnaceæ (fig. 626), the Bromeliaceæ, some Rhododendra, and the lower surface of the leaves of many ferns; they must be distinguished in the last case from the *ramenta* of the stems, which are attached by the base, and not by a central pedicle.

Fig. 626.



Scale of the epidermis of Hippophaë rhamnoides. Magnified 50 diams.

BIBL. See HAIRS and EPIDERMIS.

SCARID'IUM, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye single, cervical; rotatory organ armed with a hooked bristle in front; foot forked, very long, adapted for leaping.

Lateral processes of jaws bifurcate, so as to present two teeth each.

S. longicaudum (Pl. 35. fig. 27). Foot as long as or longer than the body, toes shorter than the foot. Aquatic; length 1-72″.

BIBL. Ehr. *Infus.* p. 439; Prit. *Infus.* p. 686.

SCENEDES'MUS, Meyen.—A genus of Desmidiaceæ.

Char. Cells fusiform or oblong, arranged side by side in a single row of from two to ten, after division forming two alternating rows; division oblique; terminal cells often lunate, or with a bristle at each end.

Several species (Ralfs).

S. quadricauda (Pl. 10. fig. 50). Cells generally four, oblong, rounded at the ends, in a single row, terminal cells with a bristle at each end. Common; length of cells 1-1120″.

S. obliquus (Pl. 10. fig. 51). Cells elliptico-fusiform, after division arranged in two distinct and generally oblique rows, end cells lunate. Length 1-1670″.

S. obtusus (Pl. 10. figs. 53 & 54, just after division). Cells three to eight, ovate or oblong, all alike, arranged in one row, or after division alternately in two rows. Common; length 1-2330 to 1-1960″.

BIBL. Ralfs, *Brit. Desmid.* p. 189.

SCEPTRONE'IS, Ehr.—An obscure genus of fossil Diatomaceæ.

BIBL. Ehrenberg, *Ber. d. Berl. Akad.* 1844, p. 264.

SCHIS'MA.—A genus of Jungermannieæ (Hepaticæ), founded on a rare British form, *S.* (*Jung.*) *juniperina*, *β. europæa*, found among rocks on the mountains of Scotland, Ireland, and Wales. It grows 3 to 6″ high, and is rarely found in fruit.

BIBL. Hook. *Brit. Flor.* ii. pt. 1. p. 124, *Brit. Jung.* pl. 4; Ekart, *Syn. Jung.* pl. 8. fig. 62; Endlicher, *Gen. Plant.* Supp. 1. No. 472–17.

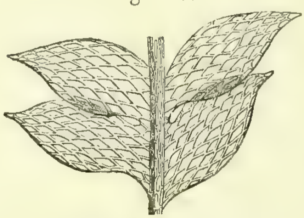
SCHISTOSTE'GEÆ.—A family of operculate Acrocarpous (terminal-fruited) Mosses of gregarious habit. Stem naked below, foliaceous in two manners above; sometimes frond-like or fern-like, composed of leaves attached vertically and connected at the base, with dense areolations consisting of rhomboidal prosenchymatous pellucid or green cells; sometimes with small leaves, like those of other Mosses, horizontal and arranged quincuncially. All the leaves nerveless and flat. Capsule without an annulus, very minute, globular-oval, with a very small convex operculum (figs. 627–630).

British Genus.

SCHISTOSTEGA. Calyptra cylindrically bell-shaped. Inflorescence diœcious, plants similar.

The only species of this genus, the elegant

Fig. 627.

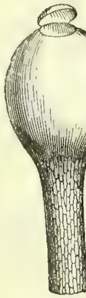


Schistostega osmundacea.
Leaves of barren branches. Magnified 50 diameters.

little *Sch. osmundacea*, Web. and Mohr (*Sch. pennata*, Hook. and Taylor), occurs here and there in Great Britain. The name was derived from what appears to have been an

erroneous observation of Hedwig, who described radiating fissures in the operculum,

Fig. 628. Fig. 629. Fig. 630.



Schistostega osmundacea.

Fig. 628. A plant and fruit. Magnified 10 diameters.

Fig. 629. Open capsule with operculum. Magnified 50 diameters.

Fig. 630. Young capsule opened, showing the columella. Magnified 50 diameters.

which do not exist in living specimens. The germinating confervoid prothallium of this moss was described by Bridel as an alga, under the name of *Catoptridium smaragdinum*; Agardh described it as a *Protococcus* (*smaragdinus*); and it was long supposed to be phosphorescent: this appears to be an error: *Schistostega* grows on the roofs of sandy caves and similar places; and the luminous appearance seems to arise from the condensation and reflection of the little daylight admitted, by the pellucid convex cellules of the prothallium.

SCHIZÆ'A, Smith.—A genus of Schizæous Ferns of curious and elegant structure. Exotic (figs. 631, 632).

SCHIZÆE'Æ.—A tribe of Polypodiaceous Ferns, with sporanges in the form of a top, and crowned by a radiated cap-like 'annulus,' which hardens at maturity, splitting the case.

Illustrative Genera.

1. *Aneimia.* Sporangia twin, sessile in two rows, on lateral lobes of the leaf, contracted into a many-times paniculate immarginate rachis, naked, splitting longitudinally outside. No indusium.

2. *Schizæa.* Sporanges sessile in two or four rows in linear membranous-margined lobes, pectinately opposite or digitate at the apex of the leaf, set among hairs, splitting longitudinally on the outside. No indusium.

Fig. 631.

Fig. 632.

Schizæa dichotoma.

Fig. 631. A fertile pinna. Magnified 5 diameters.

Fig. 632. A pinnule with sporanges. Magnified 25 diameters.

3. *Lygodium.* Sporangia sessile, alternately biseriate on marginal lobes of the leaf, splitting longitudinally, each veiled by a scale-like hood-shaped indusium adhering transversely to the nerves.

4. *Mohria.* Sporangia sessile in one row, close to the margin of the leaf, splitting longitudinally on the outside. A spurious indusium formed by the revolute margin of the leaf.

SCHIZOCH'LAMYS, A. Br.—A genus of Palmellaceæ (Confervoid Algæ). *S. gelatinosa* has been found on the Continent, growing on aquatic plants or floating free, in little gelatinous masses composed of globular green cells, 1-2000″ in diameter, surrounded by a hyaline cell-membrane. The remarkable peculiarity in this genus is the splitting of the hyaline membrane into two or four equal parts by regular, clean dehiscence, the internal cell-mass becoming divided at the same time or remaining unchanged. By frequent repetition of this splitting (the internal cell acquiring a new coat each time), the cell becomes surrounded by a number of fragments of the old coats, held together by a gelatinous matter.

Zoogonidia produced by the division and

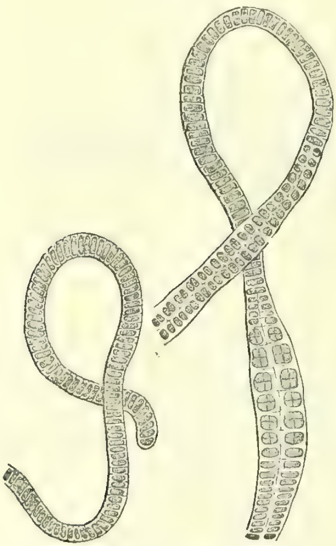
subdivision of the cell-contents. Macrogonidia and microgonidia exist.

Bibl. A. Braun, *Verjüngung, &c.* (*Ray Soc. Vol.* 1853); Kütz. *Sp. Alg.* p. 891; Rabenh. *Fl. Eur. Alg.* iii. p. 32.

SCHIZOGONIUM, Kütz.—A genus of Ulvaceæ (Confervoid Algæ), nearly related to *Prasiola*, distinguished by filiform fronds, which, when young, present only a single row of cells, but subsequently, by collateral subdivision, have two, four, or eight parallel rows. Of the species given by Kützing, the following appear to be British:

1. *S. murale* (*Bangia velutina*, Ktz., olim)

Fig. 633.



Schizogonium murale.
Filaments of frond in various stages of development.
Magnified 300 diameters.

(fig. 633). Fronds of a single row of cells 1-2400 to 1-2160" in diam.; double, 1-1440 to 1-1200"; triple, 1-720": cells half as long as broad, dull green. On damp earth.

2. *S. percursum* (*Enteromorpha*, Ag.). Frond with a double row of cells, 1-1200 to 1-900" in diam.; length of cells equal to the breadth; bright or pale green; collapsed when dry. Marine.

3. *S. lætevirens* (*Bangia*, Harv.). Frond with a simple row of cells, 1-1800 to 1-1440" in diam., rigid; with a double row, 1-600"; bright or yellowish green. Marine.

Bangia lacustris, Harv., is given as a doubtful species.

Bibl. Kütz. *Sp. Alg.* p. 350, *Tab. Phyc.* ii. pls. 98, 99; Harvey, *Brit. Alg.* 1 ed. p. 172, and *Br. Marine Alg.* p. 211.

SCHIZOLO'MA, Gaudichaud.—A genus of Davallieæ (Polypodioid Ferns). Exotic.

SCHIZOM'ERIS, Ktz.—A genus of Ulvaceæ (Algæ).

Char. Thallus filiform, flattened upwards, fixed by a hard base; growth occurs by cell-division, first in one and then in two directions, so as to form cell-groups of fours. Propagation unknown. Continental.

Bibl. Rabenh. *Fl. Eur. Alg.* iii. p. 311.

SCHIZONE'MA, Ag.—A genus of Diatomaceæ.

Char. Frustules short, resembling those of *Navicula*, aggregated in longitudinal rows in a filiform, branched, slender and lax gelatinous frond. Marine.

Sporangia (spermatia: see Micromega) external, simple, sessile upon the filaments.

Kützing describes thirty-eight species, three of which are doubtful; Smith describes seventeen as British.

S. Dillwynii (Pl. 14. fig. 12). Frond hyaline, tufted, wavy, lubricous, bright green, much branched; end branches short, numerous, patent, attenuate, and somewhat acute; frustules towards the base of the frond remote and scattered, towards the ends crowded, oblong-truncate in front view; valves lanceolate, 1-1020" in length.

Compare Homœocladia, Micromega, and Rhaphidoglœa.

Bibl. Kützing, *Bacill.* p. 111, an *Sp. Alg.* p. 97; Smith, *Brit. Diat.* ii. 71.

SCHIZOPHYL'LUM, Fr.—A genus of Agaricini, characterized by the gills splitting along the edge and becoming revolute.

S. commune is one of the commonest exotic Fungi, and is rare in this country, except introduced accidentally on foreign wood.

Bibl. Fr. *Obs.* i. p. 103; Sow. t. 183; Grev. t. 61; Berk. *Eng. Fl.* v. p. 130; Cooke, *Handb.* p. 16.

SCHIZ'OPUS, Clap. et Lach.—A genus of Oxytrichina, Infusoria ciliata.

Char. Marginal cirri absent, frontal cirri present and uncini. There are also dorsal styles. 1 sp. *S. norvegicus*, Clap. et Lach.

Bibl. Claparède et Lachmann, *Etudes*, pp. 138, 182.

SCHIZOSI'PHON, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), containing *Calothrix scopulorum*, *fasciculata*, and perhaps other species of Harvey's 'Manual.' Another British species has also been de-

scribed by Caspary, *S. Warreniæ* (Pl. 4. fig. 13). The last plant extends over large surfaces of maritime rocks, in tufts of variable size, from 1-4 to 1-2″ in thickness, of dull blackish-green colour. The erect filaments are fastigiately branched (*a*), the basal cell of the branches broader and hemispherical (*c*); the ochreal sheaths are obscure (*b*), frequently exhibiting a spiral-fibrous structure in decay (*d*, *e*); the apices of the branches are much attenuated.

BIBL. Kütz. *Sp. Alg.* p. 326, *Tab. Phyc.* ii. pl. 47 *et seq.*; Harvey, *Brit. Mar. Alg.* p. 224; Caspary, *Ann. Nat. Hist.* ser. 2. vi. p. 266, pl. 8.

SCHIZOTH'RIX, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), of which two British species, growing over maritime rocks, have been described.

1. *S. Creswellii* (Pl. 4. fig. 17). Tufts 1-2 to 3-4″ high, olive-coloured; filaments curled, 1-3600″ in diameter at the base, 1-12000″ at the summit, in twisted bundles, penicillately corymbose above.

2. *S. Smithii* (*Coleonema*), Thw. Stratum dense, dirty red; filaments closely entwined, more or less laterally concreted, 1-9600 to 1-8400″ in diameter; sheaths lax, multiplicate, the internal prolonged and exserted.

BIBL. Kütz. *Sp. Alg.* p. 320, *Tab. Phyc.* ii. pl. 40; Harvey, *Brit. Mar. Alg.* p. 223, pl. 26 B, *Phyc. Brit.* pl. 190.

SCHIZOX'YLON, Pers.—A genus of Placodei (Lichenacei).

Char. Thallus evanescent. Apothecia lecideine, elevated, naked, black. Spores numerous. One species. On oaks, rare.

BIBL. Leighton, *Brit. Lich. Flora*, p. 359.

SCHULTZE'S TEST.—This was originally proposed by Pettenkofer as a test for bile; but Schultze found that it reacted also with several other substances, and especially the proteine compounds. In this application it is often of use in discriminating one kind of tissue or substance from another. It consists in treating the matter with strong sulphuric acid, and then adding a little syrup. The characteristic reaction is the production of a purplish-red colour. The best method of proceeding is to wash the substance in question, then to moisten it with a drop of syrup, and finally to add the acid.

The tissues and substances affected by it are muscular tissue, both striated and unstriated; nerve-tubes and cells; the corpuscles of blood, pus, and mucus; epithelial and epidermic scales; hairs; feathers; horn; whalebone; and the cellular portions (cell-contents?) of Fungi and Algæ.

Those in which the reaction is not produced are areolar tissue, elastic tissue, gelatine and chondrine, chitine, silk, cellulose, gum, starch, and vegetable mucus.

BIBL. Schultze, *Liebig's Annalen*, 1849, abridged in the *Chem. Gaz.* viii. 98.

SCHULZE'S TEST.—This consists of a solution of chloriodide of zinc and is used as a test for cellulose, which it colours blue.

The orignal directions given for its preparation are indefinite; they are as follows:—dissolve zinc in muriatic acid, evaporate the solution with excess of zinc until it acquires the consistence of syrup, and dissolve in this enough iodide of potassium to saturate it; iodine is then added, and the solution diluted with water if necessary.

Radlkofer recommends zinc to be dissolved in muriatic acid, the solution to be evaporated at a temperature but little above that of boiling water, when a liquid of about 2·0 sp. gr. is obtained. This is diluted with water until its sp. gr. is 1·8; if its original sp. gr. was 2·0, 12 parts by weight of water must be added to 100 parts of the solution. In 100 parts of this liquid, 6 parts by weight of iodide of potassium are to be dissolved at a gentle heat, and the mixture heated with excess of iodine until the latter is no longer dissolved, and violet fumes become perceptible over the liquid.

This reagent has the consistence of strong sulphuric acid, and is pale yellowish-brown. It must be kept in a well-stoppered bottle.

BIBL. Schulze, *Flora*, 1850, p. 643; Schacht, *Das Mikroskop*, pp. 30 & 197; Radlkofer, *Liebig's Annal.* xciv. 332, or *Chem. Gaz.* 1855, xiii. 372.

SCIA'DIUM, Al. Braun.—A genus of Unicellular Algæ (Pl. 45. fig. 3) found in fresh water. The young plant is attached to foreign bodies, and consists of a cylindrical cell (*a*), in which are produced eight gonidia; the top of the cylinder falling off like a cap, the gonidia emerge and form an umbel of similar cylinders (*b*), the bases of which stick in the primary cell. Each new cell repeats the process, so as to form a compound umbel; but the gonidia of the third generation (*c*) are set completely free, and become the primary cells of new families.

BIBL. Alex. Braun, *Alg. Unicellul.* p. 48, tab. 4; Currey, *Microsc. Journ.* vi. p. 212.

SCIRRHOUS CANCER.—This is characterized by the large amount of its stroma.

In common with all the cancers, the cells are of an epithelial type, and they are grouped together within the alveoli of the fibrous stroma. The cells are characterized by their large size, by the diversity of their forms, and by the magnitude and prominence of their nuclei and nucleoli. (See TUMOURS.)

These cells grow luxuriantly at first on the external parts of scirrhous tumours; but subsequently they undergo retrogressive changes, and scarcely exist in the midst of the growth. This is due to the excessive growth of the dense fibrous stroma, which even, in some instances, resembles cicatricial tissue.

BIBL. Green, *Path. & Morb. Anat.* p. 173.

SCLEROCHI'LUS, G. O. Sars.—One of the *Cytheridæ*, with smooth, hard, elongate, bean-shaped valves; lower antennæ 5-jointed; upper 6-jointed, with long setæ; eye single. One living British species; common.

BIBL. Brady, *Tr. Linn. Soc.* xxvi. 455.

SCLERODER'MA, P. — A genus of Trichogastrous Fungi having a firm peridium, which bursts irregularly, containing large granulated spores separated in masses by floccose veins.

Four species have been found in this country, one of which when young is substituted for truffles, though without any of the fine aroma.

BIBL. Fr. *Syst. Myc.* iii. p. 46; Berk. *Outl.* t. 15. f. 4; Cooke, *Handb.* p. 374.

SCLEROT'ICA. See EYE (p. 297).

SCLERO'TIUM, Tode.—A large collection of fungoid structures were formerly gathered together under this name, among others the preparatory form of the ERGOT fungus. They are now all regarded as consisting of the *mycelia* of fungi in an imperfect state. The *sclerotioid* state exists when the mycelium forms hard tubercular masses. Analogous masses of mycelial structures occur, in a pulpy condition, in the Vinegar-plant; in a filamentous condition in those fungi forming large masses of barren *byssus*, &c.; in other cases, as in some of the Myxogastres, the structure is membranous.

BIBL. Léveillé, *Ann. des Sc. Nat.* 2 sér. xx. p. 218; Berkeley, *Hort. Jn.* iii. p. 97; Fries, *Summa Veg.* p. 477.

SCOLEC'IDA.—A class of the Annuloida containing seven groups, viz. Rotatoria, Turbellaria, Trematoda, Tæniada, Nematoidea, Acanthocephala, and Gordiacea.

BIBL. Huxley, *Elements of Comp. Anat.* pp. 47, 49.

SCOLIOPLEU'RA, Grunow.—A genus of Naviculaceæ (Diatomaceæ). It includes such forms as *Navicula Jenneri*, Smith, *N. Westii*, Smith, and *N. convexa*, Smith, which have the median line and furrow bent, and never straight. The line is not sigmoid as in *Pleurosigma*, but crosses the valves obliquely.

BIBL. Grunow, *in Wien. Verh. d. zool.-bot. Verein.* 1860; Smith, *Diat.* i. p. 49, f. 134, 135, 136; Rabenh. *Fl. Eur. Alg.* i. p. 228.

SCOLOPEN'DRIUM, Smith, *Hart's-tongue.*—A genus of Asplenieæ (Polypodioid Ferns), represented by the indigenous species *Sc. vulgare* (fig. 221, p. 306).

SCRUPOCELLA'RIA, Van Beneden (*Cellularia*, Johnst., part).—A genus of Infundibulate Cheilostomatous Polyzoa, of the family Cellulariadæ.

Char. Cells with a vibraculum behind, and a sessile avicularium at the upper and outer angle; orifice spinous. Two species.

1. *S. scruposa.* Cells without an operculum. Common on Algæ, &c.

2. *S. scrupea.* Cells with a stalked reniform operculum.

BIBL. Johnston, *Brit. Zooph.* 336; Busk, *Ann. Nat. Hist.* 1851, vii. 83.

SCURF OF ANIMALS.—Consists of aggregations of dry and flattened epidermic scales, sometimes containing globules of fatty matter.

SCU'TULA, Tulasne.—A genus of Coccocarpeæ (Gymnocarpous Lichens), parasitic, found upon *Peltigera canina.*

BIBL. Tulasne, *Ann. des Sc. Nat.* 3 sér. xvii. p. 118; Lindsay, *Qu. Mic. Jn.* 1869, p. 140.

SCYPHID'IA, Duj.—A genus of Infusoria, of the family VORTICELLINA, which see.

Char. Body oblong or campanulate, narrowed at the base, which is very contractile, covered with a reticular integument.

S. rugosa (Pl. 24. fig. 74). Body with oblique striæ or rugæ, not numerous. Aquatic; length 1-550''. This is not of the genus, but is a young *Vorticella.*

BIBL. Clap. et Lach. *Etudes*, p. 116.

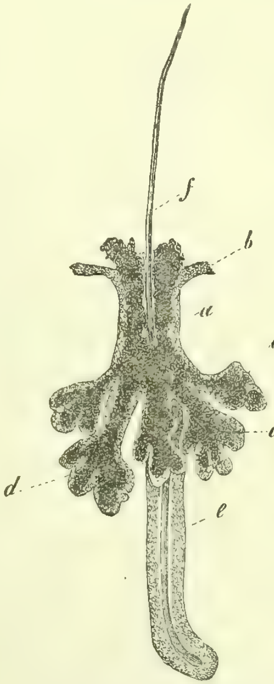
SCYTONE'MA, Berk.—A genus of Oscillatoriaceæ (Confervoid Algæ), especially distinguished by the mode of branching of the filaments. We can only make out with certainty one British species of the genus as now restricted, *S. Myochrous* (Pl. 4. fig. 19),

which grows in alpine bogs and rivulets, and is composed of decumbent filaments interwoven into a dark-brown stratum.

Bibl. Harvey, *Brit. Alg.* 1 edit. p. 155; Hassall, *Br. Fr. Alg.* p. 235, pl. 68; Kütz. *Sp. Alg.* 303, *Tab. Phyc.* ii. pl. 16 *et seq.*

SEBACEOUS FOLLICLES or GLANDS. — These organs exist pretty generally in the skin, and secrete a fatty matter. They are mostly seated close to the hair-follicles, into which their ducts usually open. They vary in form, some being simple pouches or depressions of the skin, whilst in others the deeper part of the pouch is branched, so as constitute a true

Fig. 634.



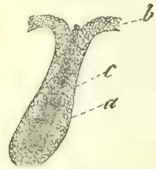
Compound sebaceous gland, from the nose, opening upon the surface with a hair-follicle. *a, b, c,* as in the next figure; *d,* lobules of the compound gland; *e,* hair-follicle (root-sheath); *f,* the hair.

Magnified 50 diameters.

racemose gland. The narrower portion, or duct, is variable in diameter; it usually opens into the hair-follicle, rather above its middle, but sometimes upon the surface of the skin itself.

Each gland consists of an outer coat of areolar tissue, forming a more or less thick

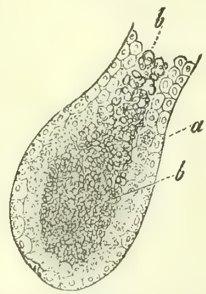
Fig. 635.



Simple sebaceous follicle, from the nose. *a,* glandular epithelium, continuous with *b,* the rete mucosum; *c,* contents of the gland, consisting of cells containing fat, with free fatty matter.

Magnified 50 diameters.

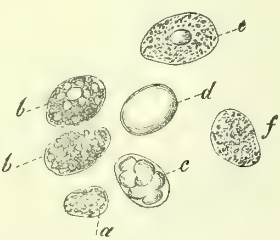
Fig 636.



Glandular vesicle of a sebaceous gland. *a,* epithelium continuous with the glandular cells *b,* containing fat.

Magnified 250 diameters.

Fig. 637.



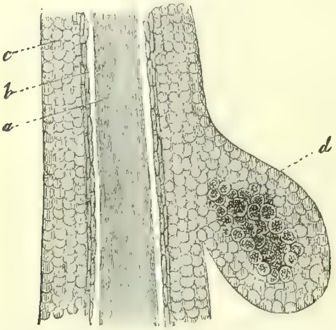
Cells from the glandular vesicles and the sebaceous secretion. *a,* small nucleated cell, containing but little fat, and resembling an epithelial cell; *b,* cells abounding in fat, without evident nuclei; *c,* cell in which the fat-globules are becoming confluent; *d,* cell containing a single drop of fat; *e, f,* cells from which part of the fat has escaped.

Magnified 350 diameters.

membrane in proportion to the size of the gland; this is derived either from the hair-follicle or the cutis, according to the situa-

tion of the gland. It is lined by layers of roundish or polygonal, epidermic or epithelial cells, the outermost of which are

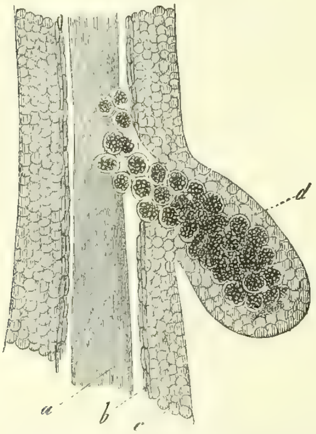
Fig. 638.



Development of the sebaceous follicles in a six-months' fœtus. *a*, hair; *b*, inner root-sheath; *c*, outer root-sheath; *d*, rudimentary follicle.
Magnified 250 diameters.

closely connected, so as to form one or more membranous layers, and contain few or no globules of fat; whilst the inner ones are larger, and almost filled with these globules.

Fig. 639.



a, *b*, *c*, *d*, as above, but in a more advanced stage.
Magnified 250 diameters.

The development of the sebaceous glands commences at the end of the fourth or in the fifth month. The glands at first consist of solid depressions or outgrowths of the rete mucosum of the skin, or the inner root-sheath of the hairs; the inner cells then become filled with fat, loosened, and are finally evacuated through that part of the immature gland which in its subsequent development forms the duct.

Bibl. Kölliker, *Mikroskop. Anat.* i. 180, and the *Bibl.* of that article; Biesiadecki, *in Stricker's Hum. & Comp. Hist.* ii. p. 236.

SECONDARY DEPOSITS, or LAYERS, of Vegetable Cells.—The structures known by this name are spoken of under the head of Cells, in a general point of view, and in detail under Pitted and Spiral Structures. A few remarks may be given here, connecting the phenomena included under the last two heads.

It is well known that the original or *primary* cell-wall, the layer of cellulose by which the cell first becomes really constituted as a closed membranous sac, is, so far as our present instruments enable us to judge, devoid of detailed structure; it is a homogeneous pellicle. This has a power of extension by interstitial nutrition, which leaves no traces in the perfect membrane, enabling the cell to increase in size. But the increase in solidity is effected by a different process, leaving distinct evidences of its occurrence, namely by an application of successive thin layers of cellulose membrane, more or less completely all over the inside of the primary membrane, giving the cell-wall a laminated character, either evident in the natural condition, or capable of being demonstrated by the aid of maceration or corrosive applications.

No cell which is to form part of a permanent tissue remains long without receiving secondary layers upon its walls. In certain cases the wall exhibits in its natural state merely the laminated structure, without any markings (Pl. 38. fig. 24); but in the majority of cases, where the secondary deposits are considerable, these layers exhibit markings of very peculiar characters. As a general rule, the layers present themselves under two different types, according to the extent to which they cover the primary membrane. In one case they are applied as a general layer over the wall, absent merely at dot-like or slit-like points, where they leave the primary wall uncovered, and thus give rise to a *pitted* condition as seen from the inside of the cell. Successive layers leaving the same spots bare, the pits become gradually deeper, and form canals running through the thick cell-wall to the

primary membrane (See PITTED STRUCTURES) (Pl. 38. fig. 23).

Another curious condition of the secondary deposits has been pointed out by Hartig and Von Mohl, where large patches or spots upon the cell-wall left bare by the thicker secondary layers become coated with a thin layer perforated by minute orifices, as if riddled with holes, or reticulated; this is described as *clathrate tissue* under PITTED STRUCTURES.

In the other case, the secondary deposits are more sparing in quantity, and are applied over lines forming a definite pattern upon the primary membrane, in which a spiral course in the direction of the long axis of the cell is more or less evident; infinite modifications of this type occur, which are treated of under the head of SPIRAL STRUCTURES (Pl. 39. figs. 7, 9).

In certain less common cases we find the earlier secondary layers exhibiting the pitted character, while others later-formed produce spiral-fibrous thickening, as in *Taxus*, the lime, and other cases (see PITTED STRUCTURES) (Pl. 39. figs. 4, 13, 19 *b*).

The last-mentioned cases point to a relation between the spiral-fibrous and the pitted layers, which appears really to exist, for in a great number of cases it is possible to distinguish a spiral structure in the membranous layers of pitted cells or even of cells where the layers of thickening merely exhibit the laminated structure without any pits or fibrous markings. Thus, in the liber-cells of the Apocynaceæ (Pl. 39. fig. 30), the thickened walls appear under a low power homogeneous, while under sufficient magnifying-power, and especially by the help of acids, we may detect an evident though delicate spiral structure. The action of acids reveals a similar spiral arrangement of the constituent molecules, in the cotton hair (Pl. 21. fig. 1), and in most liber-cells (Pl. 21. figs. 2, 5, 25), in many wood-cells, as of *Pinus*, &c. The membranes forming the sheaths of many of the Oscillatoriaceæ (Pl. 4. figs. 13 *d, e*, 15) exhibit a spiral-fibrous structure when undergoing dissolution; and an analogous condition may be detected by the help of reagents pretty generally in the cell-walls of the tubular Confervæ. All these phenomena seem to indicate a fundamental identity in secondary layers of all kinds, to which we direct attention under SPIRAL STRUCTURES; but it is convenient in practice to keep the PITTED and SPIRAL-fibrous structures distinct.

The mode of formation of the secondary deposits is not clearly known at present: some imagine them to be precipitated from the cell-sap upon the walls; others, and apparently with more reason, believe that they are attributable to the agency of the PRIMORDIAL UTRICLE, continuing its action after the formation of the primary membrane. Crüger goes so far as to consider the spiral markings, &c. as dependent on the ROTATION-currents of the protoplasm. These points require further investigation. There can be little doubt of the mistaken character of Trécul's view, which regards the spiral and other fibrous thickenings as folds of the primary wall thrown inwards.

The secondary deposits appear to be always composed of some modification of cellulose. Mohl has investigated this point very thoroughly; and we have followed him over much of the ground. The cellulose, however, loses its distinctive character with age, either by infiltration with foreign matters, or by a slight chemical metamorphosis, so that old secondary layers do not readily become blue when sulphuric acid and iodine are applied; but as a general rule the cellulose reaction may be obtained by using a preliminary treatment. All internal structures, such as wood-cells, liber-cells, stones of fruits, &c., should be boiled in nitric acid, washed, dried, and tincture of iodine applied; then, if again dried and wetted with water, they turn blue: external structures, such as epidermal cells, cork, and the like, require a similar boiling, but with solution of potash.

Secondary deposits present a considerable difference in their consistence and degree of development in different cases. In most wood- and liber-cells they are abundant in quantity, in some cases almost filling up the cavity (Pl. 38. fig. 27); here they are hard, and appear to be in that state of the cellulose-compound which may be distinguished as *lignine*. The same condition prevails in the stones of fruits, bony shells, the "grit" of pears, &c.; and the less abundant secondary substance of spiral-fibrous tissues appears to be in the same state. The secondary layers of parenchymatous cells are usually rather soft and elastic, and often turn blue with sulphuric acid and iodine alone; those of the collenchymatous tissue beneath the epidermis of many herbaceous plants, such as the Chenopodiaceæ, &c., are abundant in quantity, but of somewhat cartilaginous texture.

Those of the larger Algæ, and of the thallus of the larger Lichens, approach to the same condition, while the fleshy and horny ALBUMEN of many seeds contains abundant deposits of analogous character (Pl. 38. figs. 21–23); in the latter the composition is sometimes of *amyloid*, approaching starch, stained blue by iodine alone, and more or less soluble in dilute sulphuric acid. The secondary layer of epidermis and corky layers differs again, being usually more sparing in quantity, but very firm and elastic, and strongly resisting decomposing agents; the composition appears to be of that modification of cellulose called *suberine*.

BIBL. *Gen. Works on Structural Botany*; Mohl, *Vegetable Cell*, London, 1852, p. 10, *Botan. Zeit.* p. 97 (1847) (transl. in *Taylor's Scientific Memoirs*, 2nd ser. i. p. 95); Schacht, *Pflanzenzelle*, Berlin, 1852; Crüger, *Bot. Zeit.* xiii. p. 601, 1855; Trécul, *Ann. des Sc. Nat.* 4 sér. ii. p. 273; Wigand, *Intercellular-substanz u. Cuticula*, Brunswick, 1850; Mülder, *Phys. Chem.* Edinburgh, 1849, p. 347; Henfrey, *Elem. Course* (Masters).

SECRETING ORGANS OF PLANTS; RESERVOIRS OR RECEPTACLES for SECRETIONS.—The structures falling under this head have been in part treated of under the heads of GLANDS and LATICIFEROUS TISSUE; but there still remain certain organs of analogous character, which could not be properly included under either of the above. The name of receptacle or reservoir for peculiar secretions is ordinarily applied to groups of cells, of variable, but most frequently elongated prismatic form, containing special secretions, either in their cavities or effused into their intercellular passages, traversing in the form of cords or bundles the parenchymatous or prosenchymatous tissues. They are almost special characteristics of families, and by no means frequent; the Coniferæ, the Cycadaceæ, the Aloineous Liliaceæ, the Polygonaceæ, Compositæ, Umbelliferæ, Amygdaleous Rosaceæ, Leguminosæ, &c. afford striking examples.

In the Coniferæ the turpentine-reservoirs are very remarkable; and to a certain extent they render it possible to determine the genus by their arrangement. In *Pinus* they consist of bundles of elongated thin-walled cells, running through the wood parallel to the axis of the stem. These thin-wall cells are densely filled with turpentine; in some cases the cells of the medullary rays are likewise filled with turpentine, and, besides these, perpendicular intercellular passages; the latter form of turpentine-canal is chiefly met with in the bark. Turpentine-canals also exist in the leaves of the Coniferæ, the scales of the cones, &c.

The reservoirs of the Aloes are bundles of prismatic cells accompanying the vascular bundles of the leaves and stems. The colouring-matter of the root of rhubarb is contained in cells of imperfect medullary rays. The structure of the balsam-reservoirs of the myrrh tree, &c. has not been thoroughly studied. The resin- and oil-canals of the Umbelliferæ are of great importance; but the former, chiefly occurring in the roots, are imperfectly known. The oil-reservoir of the fruits (*vittæ*) consists of elongated excavations in the cellular tissue, filled with oil. Canals containing odoriferous oils occur in some of the Compositæ. Resin-canals occur also in the common lime.

Gum-canals, consisting of simple or branched intercellular passages with a special coat of small (secreting?) cells, occur in the leaf-stalks of Cycadaceæ, the bark of the *Amygdaleæ*, in the stems of the Malvaceæ, Cactaceæ, &c. Structures of similar nature contain the milky juices of certain plants, as of the Anacardiaceæ; and these appear to be different from the ordinary LATEX vessels.

BIBL. Meyen, *Secretions-Organe der Pflanzen*, Berlin, 1837, p. 18; Unger, *Anat. und Phys. der Pflanzen*, 1855, p. 204.

SECTIONS. See PREPARATION.

SEEDS.—These are interesting objects for microscopic examination in respect to many different characteristics. Among these may be mentioned first the variety of beautiful markings upon the surface, which render almost all seeds, like the elytra of beetles, interesting opaque objects for observation with a low power. A few striking forms are represented in Plate 31. figs. 14–18; and we give a list of kinds easily to be obtained.

Hypericum.	*Datura.*	*Maurandya.*
Lychnis.	*Nicotiana.*	*Sphenogyna.*
Stellaria.	*Petunia.*	*Hyoscyamus.*
Reseda.	*Sedum.*	*Sempervivum.*
Lepidium.	*Saxifraga.*	*Limnocharis.*
Nigella.	*Capparis.*	*Silene* (Pl. 31. figs. 16, 17).
Erica.	*Elatine.*	*Dianthus* (Pl. 31. fig. 15).
Anagallis.	*Gesnera.*	
Orobanche.	*Begonia.*	
Linaria.	*Delphinium.*	*Papaver* (Pl. 31. fig. 14).
Chironia.	*Scrophularia.*	
Gentiana.	*Antirrhinum.*	*Digitalis* (Pl. 31. fig. 18).
Mesembryanthemum.		

The following are well seen when mounted as transparent objects in Canada balsam.

Parnassia.	*Pyrola.*	*Saxifraga.*
Drosera.	*Monotropa.*	*Rhododendron.*
Orchis.	*Hydrangea.*	

The *testa* or outer skin of some of the latter (also *Begonia*), when removed from the seed and viewed with a high power, exhibits elegant pitted cells. The surface of the seed of *Cobœa* is mealy with little scales consisting of pyriform cells containing a spiral fibre (Pl. 21. fig. 20).

The surface of various seeds, such as *Collomia*, *Ruellia* (and the pericarp of many seed-like fruits, such as that of *Salvia*, *Senecio*), present remarkable forms of Hairs.

The "stones" of plums or cherries, the so-called shell of the Cocoa-nut and similar fruits, exhibit remarkably thick Secondary deposits.

The examination of the structure of ripe seeds is a matter of great importance in botany. The investigation will vary much according to circumstances. Where seeds are large, the microscope is only required for the examination of their tissues; but small seeds must be examined by dissection with needles under the simple microscope, or by sections, which are most easily made by fixing the softened seed into a piece of wax. Seeds have two coats, the *testa* and *tegmen*, or external and internal membrane, and, according as the seed is or is not albuminous, an albumen enclosing the embryo, or an embryo of larger size immediately invested by the coats. The characters of the Albumen and Embryo will be found under these heads, as also other particulars under Ovule. Embryos are either Monocotyledonous or Dicotyledonous; sometimes, however, the two cotyledons are soldered together more or less completely; in the Coniferæ and certain genera of Dicotyledonous Angiosperms, as *Schizopetalum*, the cotyledons appear to be four, six, or more in number; but the recent observations of M. Duchartre go to show that there exist only two—bifid, trifid, or multifid cotyledons. In other cases, as in *Orchis*, the embryo remains imperfectly developed, and appears as a mere cellular mass in the ripe seed before germination; this is destitute of albumen; but in *Orobanche* an amorphous embryo is found imbedded in the albumen.

Bibl. *General works on Botany.*

SEGESTREL'LA, Fr.—A genus of Verrucarieæ (Angiocarpous Lichens), containing one doubtful British plant, the *Lecanora thelostoma* of the *Brit. Fl.*

Bibl. Leighton, *Brit. Angioc. Lichens*, p. 34; Hook. *Brit. Fl.* ii. pt. 1. p. 189.

SEIROS'PORA, Harv.—A genus of Ceramiaceæ (Florideous Algæ), containing one rare species, *S. Griffithsiana*, a little crimson feathery sea-weed, composed of single articulated tubes, the joints of which are traversed by articulated filaments. The spores are unknown; but the *tetraspores*, which serve to distinguish this plant from the *Callithamnia*, occur in terminal beaded strings, being formed out of the ramuli.

Bibl. Harvey, *Brit. Mar. Alg.* p. 170, pl. 23 C.

SELAGINEL'LA, P. de Beauv.—A genus of Lycopodiaceæ, distinguished from *Lycopodium* by the presence of two kinds of spores and the dissimilar habit. This genus includes only one of our native Club-mosses, *S. spinosa* (*Lyc. selaginoides*); but most of the so-called *Lycopodia*, now so extensively cultivated in Wardian cases, fern-houses, &c., belong to this division (fig. 430, p. 472). The principal particulars relating to these plants, especially the remarkable history of the reproduction by the spores, are given under Lycopodiaceæ.

Bibl. See Lycopodiaceæ.

SELENITE.—This well-known mineral substance consists of crystallized hydrated sulphate of lime. Its crystals belong to the oblique prismatic system; and the colours exhibited by thin laminæ, into which they may be easily split, are very beautiful under polarized light. Polarizing crystals and organic substances, in which the thickness is not suited to the production of distinct colours under the polariscope, may be made to exhibit them by placing a plate of selenite beneath the object. For this purpose the plate is usually kept mounted in Canada balsam.

Bibl. That of Polarization.

SELIGE'RIA.—A genus of Leptotrichaceous Mosses, including certain *Weissiæ* and *Gymnostoma* of authors.

SENDTNE'RA, Woods.—A genus of Jungermannieæ (Hepaticæ), mostly tropical, one species of which, *S.* (*Jung.*) *Woodsii*, occurs rarely in the mountains of the S.W. of Ireland (devoid of fruit).

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 126; *Brit. Jung.* pl. 66; Ekart, *Synops. Jung.* pl. 12. fig. 108; Endlicher, *Gen. Plant.* Supp. 1. No. 472–16.

SENE'CIO.—The surface of the achænia

or seed-like fruits of the common groundsel (*Senecio vulgaris*) are sparingly clothed with HAIRS of a peculiar character. These appear to consist of two semicylindrical cells applied together by their flat faces, so as to form a kind of tube with a vertical septum. When placed in water they expand somewhat, and the contents are expelled from the ends, consisting of an indistinctly spiral-fibrous structure, which untwists and expands, by the absorption of water, to twice or three times the length of the hairs, in a manner comparable in some degree to the behaviour of the contents of the hairs of ACANTHACEÆ.

BIBL. Leighton, *Ann. Nat. Hist.* vi. p. 259.

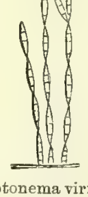
SEPEDONIE'I.—A family of Hyphomycetous Fungi, consisting of a heterogeneous assemblage of imperfectly known genera, and differently defined by different authors. Those genera we have included in our list are enumerated in Lindley's 'Vegetable Kingdom;' but Fries includes *Oidium* and others. The general character of the family is, that the plants produce spores lying immediately upon the filaments of mycelium, or upon short pedicels.

SEPEDO'NIUM, Link.—A genus of Sepedoniei (Hyphomycetous Fungi), containing two species, growing upon decaying Fungi. *S. chrysosperma* has golden-yellow spores, *S. roseum* red ones. The first is common. The species are all forms of Sphæriacei.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 350; Fries, *Summa Vegetab.* p. 497; Grev. *Sc. Crypt. Flor.* pl. 198.

SEPTONE'MA, Corda.—A genus of Torulacei (Coniomycetous Fungi), related to *Torula*, and connecting this in some measure with *Dendryphium*. *S. spiloma*, forming green tufts on old rails, has been found in Guernsey. Several species are recorded as French by Léveillé, one forming patches on vine-leaves, the others on the potato. The chains of septate spores soon break up.

Fig. 640.



Septonema viride. Magnified 200 diameters.

BIBL. Corda, *Icones*, i. & ii.; Fries, *Summa Veg.* 504; Léveillé, *Ann. des Sc. Nat.* 3 sér. ix. 261; Berkeley and Broome, *Ann. Nat. Hist.* 2 ser. v. p. 461; Berk. *Lond. Journ. Bot.* iv. t. 12. fig. 5.

SEPTO'RIA, Fr.—A genus of Sphæronemei (Coniomycetous Fungi), but probably in reality consisting of preparatory forms of *Sphæriæ*. They grow upon the leaves of plants, the fusiform septate or inarticulate thread-like "spores" oozing out from a pore in the form of a tendril.

S. Ulmi and *S. Oxyacantheæ* are common; numerous other species are recorded.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 356; Berk. and Br. *Ann. Nat. Hist.* 2 ser. v. p. 379, xiii. p. 460; Tulasne, *Ann. Nat. Hist.* 2 ser. viii. p. 117, 4 ser. v. p. 115.

SEPTOSPO'RIUM, Corda. See MACROSPORIUM.

SERIALA'RIA. See VESICULARIADÆ; and add, *S. lendigera*, the only British species, is not uncommon on Fuci, near low-water mark.

SEROUS MEMBRANES.—Consist of a basement membrane or matrix covered with cells forming an epithelium, and are in contact with lymphatics, blood-vessels, and nerves. The basement membrane is composed of connective and elastic tissue, and the first mentioned element is either in the form of a delicate trelliswork, on account of its interlacing fibres, or it may be close and more tendinous in appearance. Lymphatics, blood-vessels, and nerves pass through the interstices of the lax tissue, such, for instance, as exists in the pleura and in parts of the peritoneum. A close plexus of the fine elastic tissue runs through this trelliswork, and the quantity of the straight, undulating, or looped fibres varies in different parts of the same membrane. Fat-cells occupy the larger spaces or trabeculæ, and other cellular elements also, such as branched cells with rounded nuclei (forming a close plexus by means of their simple or branched protoplasmic processes), various-sized rounded or irregular granulated masses of protoplasm (containing one or several nuclei), fusiform granular cells with rounded or oblong nuclei, and migrating cells. Smooth muscular fibres are also found in connexion with the matrix of some serous membranes. A system of serous canals and lymphatic lacunæ (see LYMPHATIC SYSTEM), lined with epithelium, can be demonstrated in the matrix by treatment with nitrate of silver (see STAINING), and the capillary blood-vessels form a plexus, the larger ones being in close relation with the lymphatics. The free surface of the basement membrane or matrix is covered by a single layer of cells.

These are moderately flat, and differ somewhat in shape in various animals, in different serous membranes, and in the same membrane at different times of life. They may be regularly polyhedral, or may present irregular processes, so that the boundary lines of two adjacent cells are sinuous; some are triangular or rhomboidal, and there is great variety in their size even in the same membrane. The cells are nucleated, and usually the thickness of the nucleus is greater than that of the cell, so that a projection occurs; and it appears that the more regularly the cell is formed the more spheroidal is the nucleus. In the irregular cells the nucleus rarely occupies a central position; moreover, it is often oblong and constricted, and in some elongated cells there are two nuclei. The arrangement of the epithelial cells is that the polyhedric are simply juxtaposed, or when elongated their extremities are intercalated between those of the next row, or they are disposed radially in groups from four to ten around a common centre. In the centre of these groups one or more sharply defined rounded or triangular spaces exist; and there are apertures between the cells or stomata which communicate with the lymphatic system. In the investigation of the histology of serous membranes, maceration in iodized serum and staining with solution of nitrate of silver and of chloride of gold are necessary; but the fresh membrane, carefully manipulated and placed in serum or glycerine, should always be at hand to compare it with the results of the staining processes.

Bibl. Todd and Bowman, *Physiology*; Brinton, *Todd's Cyclop.* Art. *Serous and Synovial Membranes*; E. Klein, *in Stricker's Hum. & Comp. Hist.* Art. *Serous Membranes*, and the *Bibliog.* therein mentioned; with Burdon Sanderson, *in Centralblatt für medizin. wiss.* 1872; also E. Klein, *On Anatomy of Lymphatic System of Serous Membranes*, London, 1873; Beale, *How to Work*; Tourneux, *Jn. d'Anat.* 1874.

SER'PULA.—A genus of Tubicola, Annelida.

The contorted and sinuous calcareous tubes of this Annelid are common on marine shells and stones. One of the cephalic cirri is much developed, and carries a conical plug or operculum at its extremity, whereby the mouth of the tube is closed when the animal is retracted within it. (See Annulata.)

Bibl. *Books on Comp. Anat. and Zoology.*

SERTULAREL'LA, Gray.—A genus of Sertulariidæ, Hydroida.

Char. Zoophyte plant-like; stem more or less branching, jointed, rooted by a creeping stolon; hydrothecæ biserial, decidedly alternate, with a toothed orifice and an operculum composed of several pieces; gonothecæ scattered, transversely ringed, slightly dissimilar in the two sexes. *S. rugosa* (formerly *Sertularia rugosa*, Pl. 33. figs. 11 & 12).

Bibl. Hincks, *Brit. Hydr.* p. 234.

SERTULA'RIA, Linn.—A genus of Polypi (Zoophytes), of the order Hydroida, and family Sertulariidæ.

Char. Polypidom plant-like, and fixed by its base, variously branched, the branches formed of a single tube, denticulated or serrated with the cells, and jointed; hydrothecæ alternate, semialternate, or opposite, biserial, without external operculum; gonothecæ scattered.

Many of these elegant zoophytes, which would at once be referred to the vegetable kingdom by any casual observer, are commonly found on the sea-coast, either loose or attached to shells, sea-weeds, &c.

S. pumila (Pl. 33. figs. 13 & 14). Cells opposite, approximate, shortly tubular, the top everted, with an oblique somewhat mucronate aperture; vesicles ovate.

Common on Fuci near low-water mark.

S. operculata (Pl. 33. figs. 15 & 16). Cells opposite, inversely conical; aperture patulous, obliquely truncate, pointed on the outer edge, and with two small lateral teeth; vesicles obovate.

Common on Fuci near low-water mark.

Bibl. Johnston, *Brit. Zoophytes*, p. 61; Hincks, *Brit. Hydr.* p. 259.

SERTULARI'IDÆ.—A family of Thecaphorous Hydroida.

Char. Hydrothecæ perfectly sessile, more or less inserted in the stem and branches; polypites wholly retractile, with a single wreath of filiform tentacles round a cervical proboscis; gonozooids always fixed.

It includes the genera *Sertularella*, *Diphasia*, *Sertularia*, *Thuiaria*, and *Hydrallmania*.

Bibl. Hincks, *Brit. Hydr.* p. 233.

SHEEP-TICK. See Melophila.

A species of *Trichodectes* (*sphærocephalus*) is also found as a louse upon sheep.

SHELL of Animals.—In this article we shall notice the various substances comprised under the term shell, in its common acceptation. See Pl. 36. figs. 1–16.

Egg-shell.—As an example of the struc-

ture of the egg-shell of birds, we may select the shell of the egg of the common fowl.

This is lined internally by a loosely adherent layer of a thin yet firm albuminous membrane, called the membrana putaminis. It consists of a number of very slender fibres, interlacing in various directions. In imperfectly formed or soft eggs, as they are called, the fibres present thickenings at irregular intervals, resembling, on the whole, the nuclear fibres of elastic tissue with the remains of their formative cells still visible. On macerating the shell in dilute muriatic acid, an outer layer of this membrane, inseparably adherent in the natural state to the inner surface of the shell, may be detached.

The membrane may be heated to boiling in solution of potash without undergoing solution, and is insoluble in acetic acid; but it is coloured by Schultze's test.

The substance of the shell consists of numerous masses of secretion, or protoplasts, impregnated with calcareous matter. In soft eggs, these form rounded, loosely adherent masses (Pl. 36. fig. 12), may easily be detached from the surface of the egg, and contain but little calcareous matter; whilst in the perfect egg they are somewhat angular from mutual pressure, and abound in calcareous granules having an imperfectly radiating arrangement (Pl. 36. fig. 13); this is most easily perceived in the inner portions of the shell.

The structure of the shell of the ostrich presents a curious variety. In a section parallel to the surface (Pl. 36. fig. 14) the protoplast structure is distinctly visible (although omitted in the figure), but the calcareous matter is arranged in the form of triangular plates, often fused together, and leaving angular interspaces. The perpendicular section is represented in Pl. 36. fig. 15. The former section constitutes an interesting polarizing object.

Tortoise-shell.—This substance is an epidermic formation, structurally resembling horn, in so far as it consists of epidermic cells flattened and united into numerous superimposed plates. The long-continued action of solution of potash (from twenty-four to forty-eight hours), and the subsequent addition of water, are necessary to resolve tortoise-shell into its component cells.

Shells of the Mollusca.—The structure of these shells varies in the different orders, &c. of the class; and a knowledge of the respective varieties has been used as an aid to the recognition of fossils, and the determination of the affinities of the genera, families, &c.

In the bivalve Mollusca, two kinds of structure may be distinguished, an outer prismatic or fibrous, and an inner laminated.

The outer prismatic portion consists of flattened masses or plates of crowded polygonal prisms, placed sometimes perpendicularly, sometimes obliquely to the surface of the inner layer. These prisms are transparent, and polarize light, possessing a crystalline structure, although their forms are not crystalline but those resulting from mutual pressure. Transverse sections of the prismatic structure exhibit a cellular appearance (Pl. 36. figs. 4 & 11 *a*); and a somewhat similar appearance is presented by perpendicular sections (Pl. 36. figs. 5 and 11 *b*). The prisms are pretty easily separable in the lines of mutual contact, and often form several superimposed strata. They frequently contain pigment, either uniformly diffused through their substance, or in granules. They also sometimes appear transversely striated.

The inner laminated portion, which sometimes constitutes the entire shell, is either white or presents the brilliant iridescent tints of nacre or mother-of-pearl. It is often called the nacreous portion, or nacre, and when polished forms the mother-of-pearl of the shops. Under the microscope it exhibits a number of fine lines or grooves, running in various directions, and probably corresponding to the edges or intersections of the strata or laminæ of which this portion of the shell is composed; and it is to the interference of light ensuing at the surfaces of these grooves that the iridescent colours are usually owing.

In some shells (*Terebratulæ*) there are tubes traversing the substance perpendicularly (Pl. 36. fig. 7) or obliquely, or forming branched horizontal channels (Pl. 36. fig. 9 *a*, *b*); in the latter case they are sometimes connected with rounded cavities (Pl. 36. fig. 9 *a*).

In some Gasteropoda, as *Cypræa*, the outer portion of the shell consists of three layers of similar prismatic structure, but with the prisms in each layer in alternately contrary directions. The same may be seen in some of the outer layers of oyster-shell, except that the prisms are nearly horizontal or slightly oblique. But in the Acephala

generally, the structure corresponds to the inner portion of that of the Cephalophora.

Shell consists of an organic basis, in which calcareous matter, principally composed of carbonate of lime, is deposited; and by digesting it with dilute muriatic acid, the latter may be removed, an organic cast of the original being left. On treating a thin plate of nacre in this way, Dr. Carpenter found that the iridescent colours remained visible until the membrane was stretched and the supposed folds obliterated, when they vanished; hence this author concludes that the edges of the folds were the cause of the interference of light producing the colours. It appears to us, however, objectionable to this view, that the same structure and colour are produced by laminated calcareous and organic matter artificially formed; that they are also present after the edges of the folds must have been ground away, as in sections; and that the colours, in the instance mentioned, might have been those of a thin plate, and some of the colours of iridescent shell are known to be those of thin plates. It may be stated here that Dr. Carpenter considers the lines or striæ in nacre to be produced by the edges of folds of a single layer of membrane, arranged so as to lie over each other in an imbricated manner. The same author views the shell of the Mollusca as corresponding to the epidermis of the higher animals, calcified.

The outer prismatic layers of shell are secreted by the borders or margins of the mantle, whilst the inner laminated portions arise from the outer surface. The growth of shell is not uninterrupted or constant, but periodical; hence the laminated arrangement of its constituents.

In some portions of the shell of the oyster, &c., the calcareous matter assumes the form of distinct rhomboidal or hexagonal crystals (Pl. 36. fig. 10). These appear to be deposited in the inner laminated portion; and when detached they leave angular spaces corresponding to them in form. In the tooth of the shell of *Mya*, groups of radiating prisms are present, forming an elegant microscopic object.

The prisms existing in the outer portion of shells have been supposed to represent cells filled with calcareous matter; they have also been regarded as consisting of aggregations of epidermic cells, the transverse striæ (in *Pinna*) corresponding to thickenings of the cell-membranes where the layers come into contact; and the folded membrane has been compared to a basement membrane. It is probable, however, that shell should be regarded as a simple secretion from the mantle, and as corresponding in structure to egg-shell.

Shell of the Crustacea.—The hard portion of the integument of the Crustacea, alluded to at p. 206, possesses a laminated structure, corresponding to periods of growth, and giving rise to the appearance of transverse parallel lines in a perpendicular section (Pl. 36. fig. 16). The substance is traversed by numerous straight, or slightly wavy, very slender tubes (Pl. 36. fig. 16), resembling those of dentine.

Shell of Echinodermata.—The perforated structure of the homogeneous basis forming this substance has been already noticed (p. 262). In the spines of *Echinus, Cidaris,* &c., the calcareous network consists of slender fibres with large areolæ at intervals, arranged in a somewhat regular pattern, and traversing a solid homogeneous substance, which is thus divided into a number of ribs or pillars. The transverse section of these is seen in Pl. 36. figs. 6 & 6 *a*.

Dr. Carpenter regards the calcareous network as corresponding to the fibrous structure of the cutis of the higher animals, calcified. This view does not, however, account for the intervening substance.

The method of procuring sections of shell is noticed under PREPARATION.

BIBL. Carpenter, *Trans. of the British Association*, 1844 & 1847; *Ann. Nat. Hist.* 1843, xii. 376; Gray, *Phil. Trans.* 1833; Deshayes, *Todd's Cycl. of Anat., &c.*, iv. 556; Bowerbank, *Trans. Micr. Soc.* 1844, i.; Lavalle, *Ann. des Sc. Nat.* 3 sér. vii.; Siebold, *Vergl. Anat.*; Brewster, *Phil. Trans.* 1814, and *Optics*, 1853; Woodward, *On Shells*; Williamson, *Qu. Mic. Jn.* viii. p. 35; Carpenter, *Qu. Mic. Jn.* 1860, viii. p. 35, *Mo. Mic. Jn.* 1872, vii. p. 177, *The Microscope*.

SIAGONTHERIUM, Perty.—A doubtful genus of Enchelia.

BIBL. Pritchard, *Infus.* p. 614.

SIDA, Baird (*Daphnia*, auct.).—A genus of Entomostraca, of the order Cladocera, and family Daphniadæ.

Char. Anterior branch of inferior antennæ two-jointed, posterior three-jointed and with a row of spines at its anterior margin; legs six pairs.

S. crystallina (Pl. 14. fig. 27). The only species. Aquatic.

Daphnella belongs here.

BIBL. Baird, *Brit. Entomostr.* p. 107.

SIDEROLI'NA, Lamk.—Another name for CALCARINA.

BIBL. Carpenter, *Introd. For.* 199, 223.

SIDY'NUM, Sav.—A genus of Tunicate Mollusca, of the family BOTRYLLIDÆ.

S. turbinatum. Amber or orange. On the underside of shelving rocks.

BIBL. Forbes and Hanley, *Brit. Moll.* i. 13.

SILICA.—Is found as an earthy mineral, in crystals, in the form of sand, the angles and edges having been removed by friction, or as amorphous semicrystalline masses in many rocks and fossils. Connected with organic nature, it is found in or about many of the Protozoa, forming spiculæ and tests, and in many plants, such as wheat. The physical characters of silica must be known before any attempt is made to examine the microscopical structure of rocks, and they may be studied in manuals of mineralogy and in Sorby's paper, *Qu. Jn. Geol. Soc. Lond.* xiv. pp. 465, 488. But the phenomena of life modify the physical properties greatly, and spiculæ, shells, skeletons, and grains of silica are formed with definite shapes, yet these are not crystalline. Minute crystals of quartz (pure silica) are found in many sands and rock sections; they belong to the rhombohedral system, and usually occur in six-sided prisms more or less modified, terminated with six-sided pyramids. The crystals are sometimes penetrated by other minerals; and rutile especially is to be seen in some crystals, in the form of needles or fine hairs passing in every direction. Cavities also occur in quartz crystals, and are more or less filled with fluid, which may be water, naphtha, or some mineral solution. The dendritic or moss-like delineations seen in some forms of silica have been noticed under AGATE, p. 21. They are not of an organic nature. But organisms are found in siliceous minerals retaining some of their proper physical and chemical peculiarities. Thus in many specimens of silicified wood where nearly every particle of the woody fibre has been replaced by silica (soluble or not), a trace of carbon may still be found. The carbonate of lime of the hard parts of most Invertebrata is often found replaced by silica of various colours; and hence the exceeding beauty of polished thin sections of silicified sponges and corals. Chandler Roberts has noticed the organic appearances in colloid silica obtained by dialysis; but they only occur in the hydrate which has been dried from a jelly in the air, and not in the solid hydrate obtained by evaporation *in vacuo.* The appearances resemble the cells of mildew, but they do not blacken by sulphuric acid.

Many interesting attempts have been made to discover the explanation of the phenomena of the deposition of silica in or on the sarcode of organisms by comparing them with those observed during the decomposition of silicic fluoride, and the precipitation and aggregation (non-crystalline) of the silica. Schultze's formation of artificial diatoms was carried out as follows:—To obtain the artificial diatoms, powdered glass and fluor-spar are acted on by sulphuric acid. If no heat is used the silicic fluoride gas rises slowly, and if allowed to impinge against threads of cotton moistened with water a decomposition takes place; one third of the silicon unites with the oxygen of the water, and is thrown down. If the gas is passed quickly through water, the precipitate takes place in white flakes, quickly choking up a small tube. When the moist cotton threads are used and the process goes on slowly, a great quantity of irregular sausage-like tubes is formed; and when these are well washed and crushed under a covering slide, the diatom patterns will be seen with high powers. Slack, from whose essay (Mo. Mic. Jn. 1870, p. 182) this is quoted, states that "An examination of the artificial diatoms shows that purely chemical and physical considerations will account for the varieties of pattern we notice in natural diatoms; and their living structure appears only to provide the conditions under which the siliceous precipitation takes place according to the ordinary laws of chemical and molecular coalescence." Still it is evident that the silica of the diatom is absorbed by the sarcode during the process of digestion and assimilation of food which contained it, and that the deposition (so regular for certain species) is regulated by that mysterious "life" which controls the chemical and molecular coalescence. The same author has remarked on the siliceous deposit in the Pinnulariæ, and notices the conformation of the siliceous deposit of the valves of *Eupodiscus argus* to the general plan of deposition in simple forms. Slack has drawn attention to the films and beads of silica, which more or less resemble organic structures.

Amongst the higher cellular plants, per-

haps the siliceous development within the *Equisetum* is the most interesting, and it may be compared with that of the cuticle and hairs of many grasses. All are splendid objects for the action of polarized light.

BIBL. *Books on Mineralogy*; Sorby, *op. cit.*; Roberts, *Jn. Chem. Soc.* 1868, p. 275; Slack, *Mo. Mic. Jn.* passim, and June 1874, p. 277; Carpenter, *The Microscope*, pp. 383, 420.

SILK.—This valuable substance is secreted in Insects by two glandular organs, described under INSECTS, *Spinning-Organs.*

The fibres of which it is composed are cylindrical or somewhat flattened, solid, tolerably highly refractive, and free from structural markings of any kind.

Chemically, silk consists of a proper silk-cylinder, consisting of fibroine and forming the principal part of the fibres, surrounded by a coat of albumen, upon which is a layer of gelatine. The fibres also contain a small quantity of fat and colouring-matter.

Fibres of silk may easily be distinguished from those of linen or cotton by the application of Millon's or Schultze's test, both of which colour the silk, but neither of them the linen or cotton. The test for cellulose is equally applicable to the same purpose.

BIBL. That of CHEMISTRY.

SIMULTANEOUS BUNDLES. See VASCULAR TISSUE.

SIPHONA'CEÆ.—A family of Confervoid Algæ, either marine, aquatic, or growing on damp ground; characterized by the individual fronds being composed of large branched cells, the contents of which expelled in various forms serve for the reproduction. The fronds mostly have a more or less compound character, either from regular ramification, or by a kind of stoloniferous multiplication at the base of the cells; and in *Hydrodictyon*, which seems best placed in this family, the cells are always connected together by their extremities, so as to form a net-like frond. In the majority of the genera the cell-contents are green; in *Achlya*, however, they are brownish or almost colourless. The modes of reproduction exhibit considerable diversity, and are probably still imperfectly known in most of the genera. *Codium*, *Bryopsis*, and *Achlya* are reproduced by the discharge of the contents of certain cells in the form of numerous small ciliated zoospores. *Vaucheria* is increased by large elliptical solitary zoospores, covered with vibratile cilia; in *Hydrodictyon* the cell-contents are converted into a multitude of ciliated zoospores, which unite to form a new net or frond before leaving the parent cell; while in *Botrydium* the cell-contents are said to be discharged in the condition of motionless gonidia; but we imagine this point is not quite certain. In addition to the gonidial reproduction, spores have been discovered in *Achlya* and *Vaucheria*, and will probably be found in the rest. In *Achlya* these occur in special lateral sporangial branch-cells. In *Vaucheria* they also occur in special branch-cells, here, however, accompanied by antheridial cells, which produce spermatozoids, fertilizing the sporangial cell. From the fact that orifices have been observed in the wall of the sporange of *Achlya*, it is possible that an impregnation occurs there also. Spores have not yet been observed in the other genera; but it is to be expected that they will be found in them also. More particular details on the very interesting genera of this somewhat heterogeneous family will be found under their respective heads.

Synopsis of British Genera.

1. *Codium.* Filaments green, branched, closely interwoven into a spongiform frond, producing biciliated zoospores in sporangial cells borne on the sides of the erect clavate branches. Marine.

2. *Bryopsis.* Filaments green, free, pinnately branched, producing two- or four-ciliated zoospores in the extremities of the branches. Marine.

3. *Vaucheria.* Filaments green, more or less branched, continuous, producing in their apices large solitary zoospores covered with cilia; also bearing lateral globose sporangial cells and hook-like antheridial cells ("horns"). Marine or aquatic, and still more commonly on muddy ground, damp garden-pots, &c.

4. *Botrydium.* Frond a spherical green vesicle seated on a ramified filamentous base, the cavity of the whole continuous, the ramified base producing new vesicles (sporanges) by stoloniferous growth. Multiplied by the granular contents of the vesicle discharged by a rupture at the summit. On damp (mostly clayey) ground subject to floods.

5. *Hydrodictyon.* Frond a green bag-like net, with usually pentagonal open meshes, formed of cylindrical cells connected by their ends. Reproduced by ciliated zoospores formed in the "link"-cells,

uniting together and forming a perfect miniature net before escaping from the parent cell.

6. *Achlya.* Filaments colourless or light brownish (like the mycelia of Fungi), free, slightly branched; producing numerous biciliated zoospores in the apices of the filaments, and spores in globose lateral sporangial cells. On dead flies, fishes, or sometimes on decaying vegetable matter in water.

See also PYTHIUM.

BIBL. See the genera.

SIPHONI'NA, Reuss.—A low form of *Planorbulina*, having open-mouthed tubes leading off the pseudopods from the chambers, and large-necked septal orifices. Recent and fossil in the Mediterranean area.

BIBL. Parker and Jones, *Ann. N. H.* 3. xi. 94.

SIPHONOPH'ORA.—A subclass of Hydrozoa. They are the oceanic Hydrozoa.

BIBL. Huxley, *Phil. Trans.* 1849.

SIPHONOS'TOMA (Parasita, or Pœcilopoda).—An order of Crustacea.

Char. Body often almost entirely enclosed in a buckler, consisting generally of one, sometimes of two pieces; mouth suctorial; legs formed for walking or prehension, or partly branchiferous and fitted for swimming. Parasitic upon fishes, &c.

These animals (Pl. 14. figs. 7, 23, 24, 36, and Pl. 15. fig. 1), which often present the most extraordinary forms, are found mostly affixed to the gills of fishes by means of hooks, arms, or suckers, arising from or consisting of modified foot-jaws. In some, the cephalothorax is distinct from the abdomen, and the head is more or less distinct from the thorax; whilst in others the body presents more of a worm-like form, is occasionally ringed or segmented, and sometimes exhibits simple or branched lateral lobes or processes. The antennæ are mostly rudimentary. Flattened elytriform dorsal appendages are sometimes present. The rostrum is conical, tubular, and furnished with two setaceous or styliform mandibles. The alimentary canal is straight, without a gastric expansion, and its orifices at the two ends of the body. In some, branchial plates form the respiratory organs; but in most the same office is performed by the skin.

The sexes are distinct, although they are not known in all the species. The males are smaller than the females. The ova are often attached to the lower part of the body of the females, either contained in external ovaries, or simply glued together by the secretion from a special gland, and forming long, cylindrical, straight or convolute appendages. The young animals have but few legs, swim freely, and frequently resemble the young of *Cyclops*.

BIBL. Baird, *Brit. Entomostr.*; M.-Edwards, *Hist. Nat. Crust.* iii.; Siebold, *Vergleich. Anat.*

SIPHOPHYCE'Æ.—An order of Unicellular Algæ, which includes the Hydrogastreæ and Vaucheriaceæ.

SIPHULE'I.—A tribe of the series Ramalodei, family Lichenacei.

Char. Thallus podetiiform; apothecia unknown.

BIBL. Leighton, *Brit. Lich. Flora*, p. 3.

SIROC'ROCIS, Kütz. — Probably the mycelium of a fungus.

BIBL. Kützing, *Sp. Alg.* p. 153.

SIROGO'NIUM, Kützing.—*S. notabile* = *Mesocarpus notabilis*, Hass.; *S. sticticum* = *Spirogyra* (*Zygnema*, Hassall) *stictica*; *S. breviarticulatum* = *Spirogyra curvata*.

SIROSI'PHON, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), which should perhaps have been placed under the older name of HASSALLIA. This genus is principally distinguished by the solitary branches passing off from the sides of the rather rigid filaments, the branches arising from longitudinal division and lateral growth of interstitial cells. The plants are found on wet moors, rocks, &c. Two species seem to be established—*S. ocellata* (Pl. 4. fig. 12) and *S. compacta*; others appear doubtful.

BIBL. Hassall, *Brit. Fr. Alg.* p. 231, pls. 77, 78; Kützing, *Spec. Alg.* p. 315, *Tab. Phyc.* ii. pls. 36, 37.

SKELETON LARVA.—The larva of *Corethra plumicornis*, a dipterous insect, of the family Tipulidæ.

It is very transparent, and shows well the internal structure.

BIBL. Westwood, *Insects*, ii. 515; Pritchard, *Micr. Illustr.* 50.

SKELETONE'MA, Grev.—A genus of Diatomaceæ.

BIBL. Grev. *Micr. Trans.* 1865, p. 43.

SKIN OR INTEGUMENT OF ANIMALS.—Three parts are distinguishable in the skin: an outer or cellular, forming the epidermis; an inner fibrous, or cutis vera; and an internal or subjacent, known as the subcutaneous cellular tissue. The two former constitute the skin proper.

The cutis vera or corium (fig. 641 *c*) consists of areolar and elastic tissue, with fat-

cells, blood-vessels, nerves, absorbents, and unstriated muscular fibres. The fibres of the areolar tissue are variously interlaced and united into interwoven bundles, forming a tolerably dense and firm tissue, with small areolæ, and sometimes presenting laminæ. The elastic tissue is less abundant than the areolar, and consists of networks of finer or coarser fibres.

The outer surface of the cutis gives off a number of conical processes or papillæ (fig. 641 *e*), which are frequently bifid, lobed, or arise several from a common base. In many parts of the skin they are arranged in more or less regular rows.

The papillæ are of two kinds, the nervous and the vascular. Medullated nerve-fibres are present in the former, and pass to the bodies termed tactile corpuscles by Meissner; but the latter kind only contain loops of capillary blood-vessels.

Tactile corpuscles.—These are commonest in the papillæ of the terminal phalanges of the fingers. Meissner states that there are on each of these 108 tactile and 400 vascular papillæ. They occur in smaller numbers on the palm of the hand and on the sole of the foot, and on the back of the hand and foot. Like the PACINIAN bodies, they are the terminal structures of medullated nerves; but the true endings of the axis-cylinders have not yet been determined. The medullated nerve-fibres, after pursuing a tortuous course beneath the cutaneous

Fig. 641.

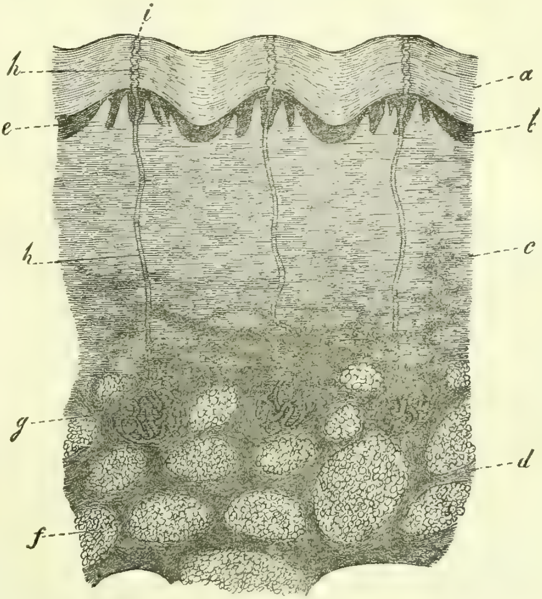


Fig. 642.

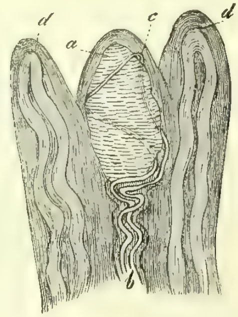


Fig. 641. Perpendicular section of the skin of the under surface of the end of the thumb, through three furrows. *a*, cuticle; *b*, rete mucosum; *c*, cutis vera; *d*, upper part of subcutaneous tissue; *e*, papillæ of the cutis; *f*, fatty tissue; *g*, sudoriparous glands; *h*, sudoriparous ducts; *i*, orifice of the latter. Magnified 20 diameters.

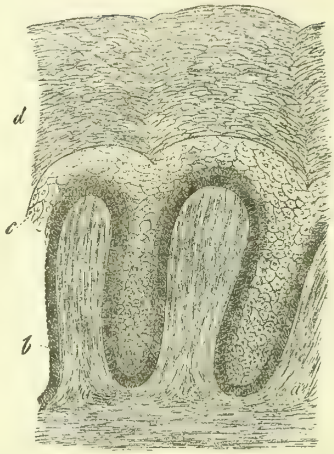
Fig. 642. Papillæ from the skin of the under part of the end of the finger. *a*, axial body; *b*, nerve; *c*, its terminal loop; *d*, *d*, loops of capillary blood-vessels. Magnified 250 diameters.

papillæ, here and there penetrate particular papillæ, which as a rule are destitute of blood-vessels and terminate in the tactile bodies. These are made more apparent by hardening the skin in solution of chromic acid, or by adding solution of potash, soda, or concentrated acetic acid to fresh skin. Broad and but slightly elevated papillæ (fig. 642 *a*) will then be seen containing oval corpuscles that equal them in length, and have a diameter of 0·02 to 0·045 of a millim. They are conspicuous for their rigid aspect and their transverse striation, which is partly owing to the presence of fine lines, and

partly to fusiform and transversely placed highly refractive nuclei. A medullated nerve (*b*) -fibre enclosed in a sheath containing many nuclei runs sometimes to the lower pole or as far as the middle or even to the extremity of the corpuscle, frequently winding once or more times round it; and at these places the corpuscle is constricted. At length the nerve suddenly loses its medulla, and is no longer to be traced. Some discrepancy of opinion exists upon all these points; and specimens that have been prepared with chloride of gold prove that from four to six nerve-fibres can be traced in the corpuscle running either obliquely or longitudinally.

The Pacinian corpuscles (see PACINIAN or VATER CORPUSCLES) are constantly present on the cutaneous nerves of the fingers and toes and of the palm and sole, but they are rarely found elsewhere in the skin. They are supplied, like the tactile corpuscles, with a medullated nerve. Besides the nerve-fibres thus supplying these bodies, there is an abundant non-medullated nervous plexus which is said to end by free extremities

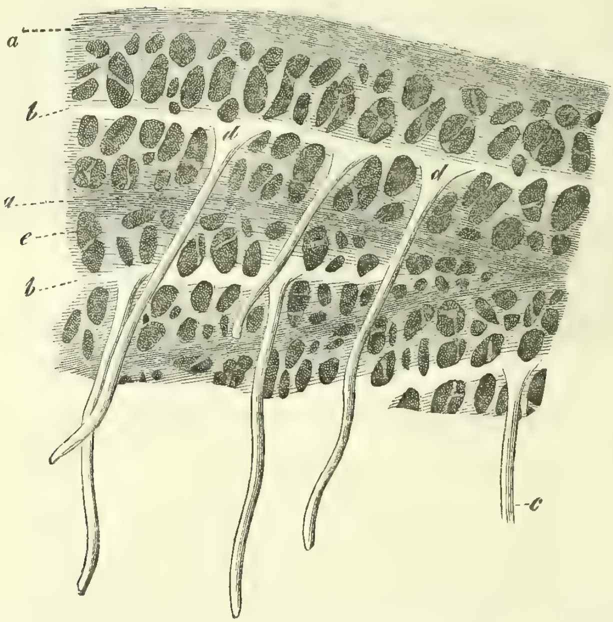
Fig. 643.



Perpendicular section of the skin of the Negro. *a*, papillæ of the cutis; *b*, deepest and most intensely coloured layer of elongated perpendicular cells of the rete mucosum; *c*, upper layer of the rete; *d*, cuticle.

Magnified 250 diameters.

Fig. 644.



Under surface of the epidermis of the palm of the hand. *a*, ridges corresponding to the furrows between the ridges of the cutis; *b*, ridges corresponding to the furrows between the rows of papillæ; *c*, sudoriparous ducts; *d*, their broad insertions in the epidermis; *e*, depressions corresponding to the papillæ.

Magnified about 20 diameters.

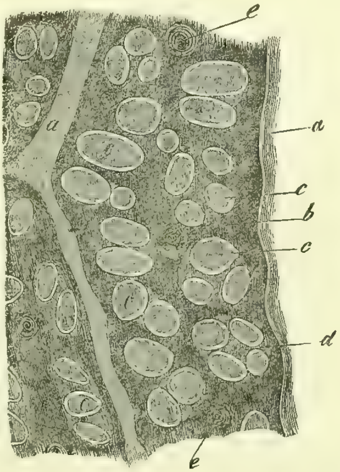
between the cells of the mucous or lowest epithelial layer. Nevertheless this supposed termination can only be seen with great difficulty and doubt, after manipulation and staining with chloride of gold and acetic acid. How the supposed termination of the non-medullated fibre amongst cells which are known to have hair-like processes can be satisfactorily determined is much to be wondered at.

The vascular papillæ are traversed by the terminal loops of the cutaneous capillaries (fig. 642 *d*).

The cutis is continuous beneath with the subcutaneous cellular or properly areolar tissue (fig. 641 *d*), which is of a much more lax texture than the cutis, presenting large areolæ filled in most but not all places with fatty tissue (fig. 641 *f*).

The cutis is everywhere covered externally

Fig. 645.



Section of the skin of the heel parallel to the surface, through one entire ridge of the skin and part of two others; showing the arrangement of the papillæ in rows corresponding to the ridges of the cutis. *a*, cuticle between the ridges; *b*, rete mucosum; *c*, papillæ; *d*, portion of the rete mucosum between papillæ arising from a common base; *e*, sudoriparous ducts.

Magnified 60 diameters.

with a thin membrane, and this by the epidermis, which is a semitransparent coat, containing neither vessels nor nerves, moulded as it were upon the surface (fig. 643) and filling up the intervals between the papillæ (fig. 644). The variously arranged lines seen upon its outer surface are depressions corresponding to those existing upon the cutis between its rows or groups of papillæ.

The epidermis consists entirely of nucleated cells; and two distinct layers are recognized in it (fig. 643), an inner forming the rete mucosum (fig. 643 *c*), and an outer or cuticle (fig. 643 *d*). The rete mucosum is softer than the cuticle, and is frequently of a brownish colour, from its cells, especially the deepest, containing granules of pigment. These cells are not all of the same form, those immediately applied to the cutis being somewhat elongated and arranged perpendicularly upon its surface and probably have no cell-wall (fig. 643 *b*). The next are cubical; and their surface often exhibits flat ribs or teeth. The cells of the next three rows are polygonal, and contain one or more nuclei; they have a distinct cell-wall, and some have hair-like processes.

The cells of the cuticle are colourless, flattened, often wrinkled or folded, and correspond to the pavement epithelium of the mucous membranes.

See Hair, Sebaceous Follicles, and Sudoriparous Glands.

In the examination of the skin, sections must be made with Valentin's knife, and these treated with acetic acid, solution of potash, dilute nitric acid, &c. The blood-vessels are well seen as regards general arrangement in injected preparations, some of which, as those of the pulp of the finger, form very beautiful objects. The epidermis is easily separated by maceration.

The integument of animals is noticed under the respective heads of the classes.

It must be remarked that the terms epidermis and cuticle are generally used synonymously.

Bibl. Kölliker, *Mik. Anat.* i., and *Gewebelehre*; Todd and Bowman, *Phys. Anat.* &c.; Meissner, *Beitr. z. Anat. u. Phys. der Haut*, Leipzig, 1863; Biesiadecki, *in Stricker's Hum. & Comp. Anat.*

SMARIS, or Smaridia, Latr.—A genus of Arachnida, of the order Acarina, and family Trombidina.

Char. Palpi slender, inserted upon a retractile rostrum; mandibles sword-shaped; body entire, narrowed in front; coxæ stout, distant, the anterior articulated to a fixed eminence upon the body; legs palpatorial (used also as palpi), the anterior longest.

S. papillosa (Pl. 2. fig. 36; *a*, mandible). Body vermilion-coloured, broader in front,

depressed, covered with short cylindrical papillæ rounded at the end.

Found upon the trunks of trees, and in moss.

Fusiform scales replace the papillæ upon the legs, palpi, and rostrum.

Several other species are found in moss, upon fallen leaves, and on the *débris* left after inundations.

Bibl. Dugès, *Ann. des Sc. Nat.* 2 sér. i. 16 & 34; Gervais, *Walckenaer's Apt.* iii. 173.

SMUT. See Uredo.

SNAILS, WATER-.—Most microscopic observers, ever anxious to determine the unknown cause of the curious circulation or rotation (Rotation) taking place in certain water-plants, as *Vallisneria, Anacharis,* &c., keep these growing in large glass vessels, as confectioners' jars, or other reservoirs (Vivaria). These plants, and the sides of the vessels, are, however, very apt to become overgrown and obscured by Confervoid Algæ (as *Œdogonium*), Palmellaceæ, &c., which may be prevented by keeping water-snails in the water, as species of *Limnæus, Physa, Bythinia, Planorbis,* &c. The latter are best for this purpose (the shell is flat-spiral). If Desmidiaceæ, Diatomaceæ, Infusoria, &c. are to be preserved, the snails must be carefully excluded, because many of these are consumed by them, and will not live, as the bottom of the vessels soon becomes covered, when snails are kept, with a load of excrement. The characters of the snails are too long to be given here. The gelatinous masses of ova are found adhering to water-plants.

See the *Bibl.* of Mollusca.

SNOW.—The various forms presented by ice or crystallized water in the form of snow constitute beautiful although fugitive microscopic objects.

The crystals belong to the rhombohedric or hexagonal system. Several hundreds of forms have been observed, and many of them figured. Among them may be mentioned hexagonal or dodecahedral plates, hexagonal prisms, single, arranged in a stellate form, or terminated by rectangularly placed plates or secondary groups of needles, hexagonal pyramids, &c. The angles of these forms frequently constitute secondary centres, around which other similar or dissimilar forms are aggregated. By some authors these forms are regarded as skeleton crystals.

See also Red Snow.

Bibl. Scoresby, *Account of the Arctic Regions*; Kämtz, *Meteorologie*; Glaisher, *Micr. Journ.* 1855. iii.; Naumann, *Elem. d. Mineralogie.*

SODA.—Kölliker recommends a solution of caustic soda, in preference to potash, for the resolution of some of the tissues into their component elements. We have been unable to detect any marked difference between the action of these two solutions; and the former has the disadvantage of lifting the stopper from the bottle by the crystallization of the carbonate formed, so that it is with difficulty preserved.

Pl. 6. fig. 15 represents the crystals of oxalate of soda; and fig. 19 those of the nitrate (Urea).

SODIUM, Chloride of, or common salt.—The crystals of this salt belong to the regular system. The most common form is the cube terminated by quadrangular pyramids or quadrangular pyramidal depressions, rectangular tables, &c. Schmidt endeavours to show that the primary form of the crystals is the octahedron, and that the cubes are twin octahedra. The crystals do not polarize light.

Bibl. Schmidt, *Entwurf ein. allg. Untersuch. &c.* p. 90, and the *Bibl.* of Chemistry.

SŒMMERING, Mirror of.—Introduction, p. xix.

SOLENOPH'RYA, Clap. et Lach.—A genus of Acinetina (Suctorial Infusoria).

Char. The form is sessile and has a sheath, the suckers are not branched but simple and attached separately to the body. Found attached to roots of *Lemna minor* at Berlin.

Bibl. Clap. et Lach. *Etudes,* p. 389.

SO'LIUM, Heib.—A genus of Biddulphieæ (Diatomaceæ).

Bibl. Rabenht. *Fl. Eur. Alg.* i. p. 319.

SOLORI'NA, Ach.—A genus of Parmeliaceous Lichens, intermediate between *Peltigera* and *Sticta. S. crocea* and *S. saccata* occur in mountainous districts.

SOMA'TIA.—Minute amyloid corpuscles in the fovilla of pollen, size $\frac{1}{3}$ of a blood-corpuscle. They exhibit oscillating movements.

Bibl. Saccardo, *Nuovo Giorn. Bot. Ital.* 1872, p. 241; *Qu. Mic. Jn.* 1873, p. 295.

SORAS'TRUM, Kütz.—A genus of Pediastreæ (Desmidiaceæ).

Char. Frond or family solid, globular, composed of cuneiform or cordate cells, somewhat compressed and united into globular families; their narrow ends meeting in the centre are broadly emarginate or divided.

BIBL. Archer in *Prit. Infus.* p. 755; Rabenht. *Fl. Eur. Alg.* iii. p. 81; Carter, *Ann. Nat. Hist.* 1869, December.

SORI'TES, Ehr. See AMPHISORUS and ORBITOLITES.

SOROS'PORA, Hass.—A genus of Palmellaceæ (Confervoid Algæ) not clearly distinguished from *Glœocapsa* and *Protococcus.*

BIBL. Hassall, *Brit. Freshw. Algæ*, p. 309.

SOROTHE'LIA, Körb.—A genus of Micro-lichens, parasitic on the thallus of *Plyctis argena.*

Char. Spores 8, 2-locular, brown.

BIBL. Lindsay, *Qu. Mic. Jn.* 1869, p. 343.

SO'RUS.—The name applied to the aggregation of sporanges of the FERNS; sometimes applied also to the groups of spores in the Florideous Algæ.

SPATHID'IUM, Duj.—A doubtful genus of Infusoria, of the family Leucophryina.

Char. Body oblong, thicker and rounded behind; thinner, broader, and obliquely truncate in front.

S. hyalinum (*Leucophrys spathula*, E.) (Pl. 24. figs. 75 & 76). Hyaline; anterior margin with irregularly arranged minute black points.

Ehrenberg figures a row of cilia at the anterior end of the body.

BIBL. Duj. *Infus.* p. 458; Clap. et Lach. *Etudes*, p. 230.

SPATHULA'RIA, P.—A genus of Helvellacei (Ascomycetous Fungi), with a fertile head running down the stem on either side. *S. flavida* is one of our prettiest Fungi when in perfection.

BIBL. Grev. t. 165; Berk. *Outl.* t. 21. fig. 7; Cooke, *Handb.* p. 661.

SPERMATIA.—The minute corpuscles supposed to represent spermatozoids in the LICHENS (Pl. 29. figs. 3, 15, 16) and FUNGI (Pl. 20. figs. 2, 3, 4).

SPERMATOZO'A or SPERMATOZO'OIDS (Pl. 41).—Constitute the male element of the generative process, and present a great variety of form in the animal kingdom.

Infusoria. Balbiani and G. Müller have described thread-like bodies which are developed within the nucleolus (see INFUSORIA, p. 407).

Spongida. Huxley described spermatozoa in *Tethya*, and Lieberkühn in *Spongilla*; they have an oval head and a thread-like prolongation.

Cœlenterata. The Actinozoa have minute seminal bodies which have a round or ovoid head and a long filament; and this is the case with such Hydrozoa as *Pelagia* for instance.

Annuloida. The Echinodermata have spermatozoa with a pin shape, for example in *Holothuria*, *Spatangia*, and *Echinus.*

The Nematoda, except *Pentastomum*, in which the spermatozoa are linear, have them of very different shapes. Some consist of a roundish or oval corpuscle and a short rigid peduncle, as in *Strongylus*; *Gordius* has them in the shape of short rods. The Rotifers, according to Kölliker, have linear-shaped spermatozoa, with small club-shaped heads; there is some doubt about this, however. But Leydig described those of *Notommata* as sickle-shaped bodies with nucleus and nucleolus, and an undulating membrane at the border; he also observed thick rod-like bodies with a central thickening. Probably the first are not and the last are spermatozoa.

Annelida. The earthworm has spermatozoa somewhat thickened at one end so as to present a thick rod there; and another genus has them very attenuated and spirally coiled. In the leech they are very delicate short thin fibres.

Arthropoda. The spermatozoa have great uniformity of shape amongst the Insecta, and are capilliform threads pointed at each extremity; but the anterior end is slightly thicker than the other. An angular appendage is adherent to one end in the *Locustidæ.*

Arachnida. Great diversity of the shape of the spermatozoa exists in this group. In *Scorpio* the hair-like form is seen. In Tardigrada they are fusiform, with an oval head, whence proceed two vibrating threads. In the Araneæ seminal cells have been described by V. Siebold, and long, curved, club-shaped bodies with a short appendage as true spermatozoa (in *Clubiona*) by Wagner and Leuckart. In *Epeira*, however, the tail end does not exist. The Acaridæ have spheroidal, fusiform, club-shaped, and rod-like spermatozoa.

Myriapoda. The spermatozoa are of two types. In the Chilognatha they are fusiform, conical, and cocked-hat-shaped; and in Chilopoda they are long mobile threads.

Crustacea. In *Balanus* and *Lepas* the spermatozoa are simple and capilliform. In *Cyclops* they are rod-shaped, with two coils, and in *Cyclopsina* they are oval. Zenker and Metschnikow state that the

spermatozoa of the Ostracoda possess a very remarkable and complex form. In *Cypris ovum* they are three times the length of the animal, and have the form of a coiled rod bordered lengthwise by a spiral plate. Those of *Cythere viridis* have a lash with one broad abrupt extremity, and also a more pointed one, to which a pedicel is attached at right angles, and which appears to be twisted like a ribbon round its axis.

The Decapoda have spermatozoa in the form of thick cell-like bodies that give off fibrous processes like rays; possibly the rays can be drawn into the head, which becomes spheroidal. *Mysis* has them capilliform in shape; and *Crangon* and *Palæmon* have them as flattened vesicles, from the centre of which a short spur projects. The Amphipoda have spermatozoa in the form of stiff threads pointed at either extremity, or they may have, as in *Azellus*, a cylindrical pointed appendage which is bent angularly.

Molluscoida. The spermatozoa of Polyzoa have usually the shape of a pin with a more or less flattened head. In *Flustra carnosa* they are linear and slightly sinuous. In *Alcyonidium* they exhibit a pointed body with a flat and a bulging side and with an attached fibre, which is thickest in the middle. In the Salpidæ the hair-like form reappears; whilst in the Ascidia the head is cylindrical, pyriform, or elliptical, and the body capilliform.

Mollusca. In the Lamellibranchiata cylindrical, oval, or pyriform bodies exist, with delicate capilliform tails. In Pteropoda the spermatozoa are thickened at one end and then slightly twisted, whilst the other end is continued into a true thread, which, just before its termination, dilates into a small vesicle. In the Gasteropoda there is much diversity of form. In some (*Chiton*, *Trochus*, *Patella*) the head is oval, pyriform, or sometimes constricted in the middle; in others (*Turbo*, *Buccinum*, *Purpura*) the shape is capilliform, and pointed at both extremities. In *Doris* the fibre increases in thickness towards the extremity, and appears slightly twisted. Two forms occur in *Paludina vivipara*: one is short and twisted like a corkscrew at its upper end, whilst the other is larger and rod-like, with a bush of short fibres. In *Atalanta*, amongst the Heteropoda, the spermatozoa are elongated and anteriorly thickened bodies, which gradually attenuate to a very delicate fibre. In Cephalopoda the spermatozoa are cylindrical, with a delicate capilliform appendage; or, as in *Octopus*, they form hair-like structures.

Pisces. The spermatozoa of *Amphioxus* are thread-like bodies with roundish heads; and those of the Petromyxidæ are rod- or egg-shaped. The osseous fishes have them as small pin-shaped bodies; and in some (*Cobitis*) there is a second enlargement. Those of the Salmonidæ have an elongated head, pointed anteriorly so as to resemble the heart on a picture card, and consisting of two parts separated from each other by a slight groove. The Sharks and Rays have spermatozoa which are larger than those just mentioned, and are provided with a fusiform and frequently spirally twisted head.

Amphibia. The spermatozoa of the Tritons and Salamander are remarkable objects. The fusiform head is continuous with a long thread, to the margin of which an undulating border is attached like a frill. In the Frogs, *Rana esculenta* has spermatozoa with a capitate extremity, thick and cylindrical, but *R. temporaria* has a linear form.

Reptilia. The spermatozoa of the scaly reptiles have a thickened cylindrical or fusiform head, with a long tail.

Aves. A similar form occurs in birds. The head is either simple, cylindrical, and straight, as in the Pigeon, Heron, Gull, &c., or it has acute edges, and is twisted spirally (Canary).

Mammalia. Instead of the long head of the spermatozoa of birds, those of the Mammalia have a thickened capitate extremity, approximating more or less to the form of a disk; their tail is not so long or so delicate as that of Aves. In the Pig the head is oval, with a recurved point, and is equally flattened on the two sides. Those of the Bull, Sheep, and Horse possess a similar form. Amongst the *Rodentia* their shape is very various. In the Rabbit the capitate extremity is oval, flattened at the sides, and truncated where it is attached to the thread-like tail. In the Guinea-pig it forms an almost circular disk that presents a cap-like appendage at the upper border. Those of the Rat and Mouse have a hatchet-shaped head and long tail. In the Dog the head is pyriform; in the Cat it is oval, the tail arising from the broader side. The spermatozoa of the Hedgehog have a truncated head, with lateral insertion of the tail. Those of the Bat are truncated and oval, with a tail attached to the middle of the lower border.

In the Monkey the head is oval, with the broader extremity towards the tail. In Man the spermatozoa present an oval head, with a thickened and rounded posterior border, to which the tail is attached. The head is prolonged anteriorly into a thin disk slightly depressed in the centre. The thickening is sometimes greater on one side than on the other.

In minute structure the spermatozoa probably consist of two parts—a structureless investment and contractile contents. In the Bear there are three band-like bodies in rows on the tail. The spermotozoa are motionless in some, but are mobile in others and in the majority of animals. The movement is either amœboid or produced by lashing of the protoplasm of the interior, assisted by the undulating membranes when they exist. *Spermatophores*, or sperm-ropes, occur in the Cephalopoda in bags containing spermatozoa, which are transferred to the female organ. In some insects they have the form of a pedunculated globule (*Lepidoptera*); but in *Carabæa* the spermatozoa are aggregated in band-like strings. In *Tubifex*, one of the Annelida, these string-like masses have also been described.

Spermatozoa may be best examined and preserved by washing them with distilled water, and drying them upon a slide.

See Testes.

Bibl. Kölliker, *Mik. Anat.* ii. 393; id. *Sieb. u. Köll. Zeit.* vii. 201; id. *Beitr. z. Kenntn. d. Geschlechts. d. wirb. Thiere*; Siebold, *Vergl. Anat.*, passim; Czermak, *Sieb. u. Köll. Zeit.* ii.; Wagner, *Todd's Cycl. of Anat. &c.* iv., art. *Semen*; id. *Physiology, by Willis*; Leuckart, *Wagner's Handwört. d. Phys.* iv. 819; Beneden, *Anat. Comp.*; Dujard. *Observ. au Microsc.*; Owsiannikoff, *Mo. Mic. Jn.* i. p. 312; E. Ray Lankester, *Qu. Mic. Jn.* 1871; St. George, *in Stricker's Hum. & Comp. Hist.* ii. p. 141, and *Bibl.*

SPERMATOZO'IDS, or ANTHEROZO'IDS.—The terms applied to the structures produced in the antheridia of the Cryptogamia, regarded as analogous to the spermatozoa of animals, and as the agents of fertilization of the germ-cell. In the Marsileaceæ, Lycopodiaceæ, Equisetaceæ, Ferns (Pl. 32. fig. 34), Mosses (Pl. 32. fig. 33), Hepaticæ (Pl. 32. fig. 32) and Characeæ (Pl. 32. fig. 31), they are ciliated spirally-coiled filaments, exhibiting very active spontaneous motion. In the Fucoid Algæ, they are globular cells bearing two unequal cilia moving actively. In the Florideæ they are minute globular cells, and neither cilia nor movement have been certainly demonstrated. In the Lichens and Fungi the Spermatia (Pl. 20. fig. 4; Pl. 29. fig. 15) appear to represent the spermatozoids of the other classes, and they seem to be devoid of spontaneous movement. The details respecting these bodies are given under their respective classes.

Bibl. Thuret, *Ann. d. Sc. Nat.* 3 sér. xiv. p. 214, and xvi. p. 5; Schacht, *Die Sperm. im Pflanz.* 1864, & *Qu. Mic. Jn.* 1865. See also under the families.

SPERMOGO'NIA.—The supposed antheridial structures of Lichens (Pl. 29. figs. 2, 13, 15) and Fungi (Pl. 20. figs. 1 and 4).

SPERMOSI'RA, Kützing.—A genus of Nostochaceæ, growing in salt marshes, containing two British species; known from the other genera by the disk-shaped or lenticular cells; but the filaments are liable to be mistaken for a *Nostoc* in the young state.

1. *Spermosira litorea*, Kütz. Filaments 1-3600″ thick, straightish, æruginous; ordinary cells confluent, very short; sporangial cells at first green, depressed-spheroidal, 1-3000″ in diameter, granulate, fuscous when mature; vesicular cells transversely elliptical, not wider than the ordinary cells. Kützing, *Tab. Phyc.* vol. i. pl. 100. fig. 3; Harvey, *Phyc. Brit.* pl. 93. fig. C, *Manual of Brit Alg.* 2nd edit. pl. 27 E. In muddy brackish ditches.

2. *S. Harveyana*, Thwaites. Filaments much curved; cells nearly as long as broad; sporangial cells exactly spherical, almost twice the diameter of the ordinary cells; vesicular cells subquadrate, rather longer than wide, about as wide as the ordinary cells. Harvey, *Phyc. Brit.* pl. 173 C. In muddy brackish ditches.

Bibl. As above, and Rabenht. *Fl. Eur. Alg.* ii. p. 185.

SPHACELA'RIA, Lyngb.—A genus of Ectocarpaceæ (Fucoid Algæ), containing a number of species, two of which, *S. scoparia* and *S. cirrhosa*, are common. They have jointed, rigid, distichously branched, feathery filamentous fronds, of an olive colour, a few inches high, and are especially characterized by the *sphacelæ* formed at the ends of the branches. They multiply by zoospores produced in unilocular or plurilocular sporangia. The propagula are produced on the lateral branches, and are connected by a cell which may produce several of them.

Each consists of a pedicel of three rays and of a multicellular pair. The rays and pedicel produce when they come into contact with those of another Alga, short shields like a prothallus, of which the peripheral cells may produce new plants.

Bibl. Harvey, *Brit. Mar. Alg.* p. 55. pl. 9 B; Janczewski, *Mém. de la Soc. Nat. d. Sc. Nat. de Cherbourg*, xvi. p. 337.

SPHÆ'RIA, Hall.—A genus of Sphæriacei (Ascomycetous Fungi), now somewhat reduced from its ancient limits, but still containing a vast number of species, which it is impossible to treat satisfactorily within our limits. The forms vary chiefly in regard to the perithecia, which are sometimes only covered by a veil, and hence appear superficial on the matrix, while in other cases they are imbedded in the matrix,

Fig. 646.

Sphæria quaternata.
Three groups growing on a piece of beech-wood.
Magnified 20 diameters.

only evident externally by the black papilla, which is permanent, becoming indurated, and opening by a pore to discharge the spores in a fine powder. Many of the immersed kinds are only evident externally

Fig. 647.

Fig. 648.

Sphæria convergens.
Magnified 20 diameters.

Fig. 649.

Sphæria verrucosa.
Magnified 20 diameters.

as minute black points or dots upon the surface of the leaf, stem, &c. which they infest; others are exposed freely when mature, breaking out from beneath the epidermis. Sometimes they are solitary, sometimes associated in small or large numbers, distinct or confluent. *S. quaternata* (fig. 646) is an example of the occurrence of free perithecia grouped together, mostly in fours; being decumbent, their ostioles are collected together, and they perforate the bark by a little black rugged tubercle. This is common on beech-trees. *S. convergens* (figs. 647, 648) is an analogous form. *S. elongata* (figs. 655–657) affords an example of those species which are at first immersed and adnate, and finally burst forth and become nearly free.

For species now separated from this genus see Claviceps, Hypoxylon, Xylaria, Hypocrea, and Nectria.

Certain points of great interest have lately been ascertained respecting this genus and its allies, which are mentioned under the heads of the family and other genera, namely the coincidence and evident connexion between true species of *Sphæria* and various Coniomycetous Fungi; for just as *Melasmia* is a precursory form of *Dothidea*, *Tubercularia* of *Nectria*, &c., *Cytispora*, *Septoria*, and other forms precede *Sphæria*, and many distinct stylosporous forms are associated, usually described as belonging to distinct genera, such as *Stilbospora*, *Sporocadus*, *Sphæropsis*, &c. Thus these plants seem to produce three kinds of reproductive organs, as is now known to be the case with the Uredinei, viz.:—(1) a form analogous to the *spermogonia* of the Lichens (in *Sphæria* represented by *Cytispora*, &c.); (2) an ascophorous fruit, the perithecium of the true *Sphæria*; and (3) a stylosporous fruit, representing the genera *Stilbospora*, *Sporocadus*, &c.

S. Laburni has been found by Tulasne to exhibit all these stages, namely perithecia containing asci, surrounding a cytispore, with other conceptacles on the same stroma resembling the perithecia, but lined with stylospores instead of asci. Berkeley and Broome also describe the existence of the perithecia of *Sphæria inquinans* and the conceptacles of *Stilbospora macrosperma* on the same stroma (Pl. 20. figs. 25–28).

It is stated by Tulasne that the 'spermatia' of the cytisporous forms may be contemporaneous with the stylospores or basidiospores, but they always precede the ascopores in their development; hence there is ground for supposing that they represent the spermatozoids of the higher Cryptogamia. With regard to the relations of the stylospores, it is possible that they

are merely modifications of the ascospores; but it would appear probable that they must be regarded as real gonidial structures, for which it may be desirable to retain Fries's name of *conidia*, just as that of *tetraspores* is retained among the Florideous Algæ. Attention should be directed here to the complete correspondence between the series of forms of these genera and those of the UREDINEI, where, as in PUCCINIA, we have the *spermogonium* (cytispore), the *uredo* (stylosporous fruit), and the *perfect fruit* (perithecium). See also CONIOMYCETES.

Mr. Currey has recently published some extensive observations on the spores of the *Sphæriæ*.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 232; *Ann. Nat. Hist.* i. p. 205, vi. p. 360, 2 ser. v. p. 374, vii. p. 186; *Hook. Journ. Bot.* iii. p. 319; Fries, *Summa Veget.* p. 388, *Syst. Mycol.* ii. p. 319; Tulasne, *Ann. d. Sc. Nat.* 3 sér. xv. p. 375 (*Ann. Nat. Hist.* 2 ser. viii. p. 117), 4 sér. v. p. 108, viii. p. 35; Currey, *Mic. Jn.* iii. 263 (1855), *Linn. Tr.* vol. xxii. p. 257; Carpenter, *The Microscope*, p. 356.

SPHÆRIACEI.—A family of Ascomycetous Fungi, containing a vast number of parasitic plants, mostly of minute dimensions, growing upon leaves, stems, bark, wood, &c., and sometimes on the bodies of insects. The essential distinctive character lies in the globular, ovate, or flask-shaped conceptacle or *perithecium*, containing asci, which ultimately opens by a pore at its summit to discharge the spores. These perithecia occur either solitary or in groups on an indistinct matrix, growing out from the epidermis of leaves, &c. (*Sphæria*); or they are immersed in a tubercular stroma (*Nectria*), while in the larger forms the stroma becomes developed into an erect clavate or bushy structure, of a fleshy or horny consistence, the perithecia being imbedded in the superficial layer of this, and opening by pores on the surface. Much remains to be done in reference to the history of this family, not merely on account of the polymorphous characters of the ascophorous forms, but from the circumstance that it has recently been shown, as was suspected before, that there is a relationship existing between them and the supposed genera of Coniomycetous Fungi of similar habit. These last are in fact mostly forms of Sphæriaceous Fungi, as is indicated under the heads CONIOMYCETES, ASCOMYCETES, DOTHIDEA, SPHÆRIA, CYTISPORA, SEPTORIA. Our treatment of this family is very imperfect, the knowledge of them being confined to few persons, and much of it lying scattered in fragments.

Synopsis of British Genera.

* *Stroma erect.*

1. *Claviceps.* Stroma simple, clavate; perithecia superficial, in a distinct layer at the summit of the clavate stroma; asci tubular, spores very long, multiseptate.

2. *Xylaria.* Stroma simple or branched; perithecia spread all over, often wanting at the summit, black; asci eight-spored, spores uniseptate.

3. *Thamnomyces.* Stroma branched, shrubby, or stalk-like; perithecia formed from the stroma, more or less naked; asci tubular; spores simple, ovate.

** *Stroma between erect and horizontal.*

4. *Poronia.* Stroma cup-shaped, stipitate or sessile, margined; perithecia in the disk, superficial; ostioles even slightly prominent.

*** *Stroma horizontal.*

5. *Hypocrea.* Stroma distinct from the matrix, tubercular; perithecia immersed; asci filiform; spores simple or uniseptate.

Fig. 650.

Fig. 651.

Fig. 652.

Xylaria guianensis.

Fig. 650. A stroma. Nat. size.
Fig. 651. Vertical section of the same. Nat. size.
Fig. 652. Section of a perithecium. Magnified 10 diameters.

6. *Hypoxylon.* Stroma distinct from the matrix, at first covered with a floccose

mealy veil: perithecia black: asci linear-clavate: spores subseptate, expelled in a cloud of black powder.

Fig. 653. Fig. 654.

Xylaria grammica.

Fig. 653. Natural size.
Fig. 654. Horizontal section. Magnified 5 diameters.

Fig. 657.

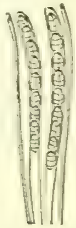
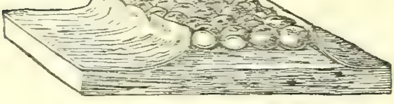


Fig. 655.

Fig. 656.



Sphæria elongata.

Fig. 655. Erumpent lines of perithecia. Nat. size.
Fig. 656. Portion of one in end view. Magnified 20 diameters.
Fig. 657. Asci and paraphyses from a perithecium. Magnified 200 diameters.

7. *Diatrype.* Stroma partly formed from the matrix, not distinct; perithecia deep-seated, produced into a long neck, and frequently a beak; spores simple and pellucid.

8. *Dothidea.* Perithecia indistinguishable from the stroma; asci collected into a globose nucleus with a neck above, leading to an ostiolate papilla.

**** *Stroma wanting; the perithecia often seated on a tuberculous, crustaceous, byssoid, macular mycelium.*

9. *Nectria.* Perithecia free, membranous, flaccid, brightly coloured, with a pale papilla, nucleus pale; asci eight-spored; spores pellucid.

10. *Oomyces.* Perithecia erect, several contained in a shining sac, free towards the upper part; ostiole punctiform; asci linear; spore filiform, very long.

11. *Sphæria.* Perithecia black, papilla covered by a veil or by the matrix, sometimes beaked, indurated, ostiolate, black; asci usually eight-spored; spores usually septate, discharged as a powder.

SPHÆROBOLUS, Tode.—A genus of Nidularini (Gasteromycetous Fungi), consisting of a peridium of several layers, the inner one of which is suddenly reversed, and discharges the globose sporangia.

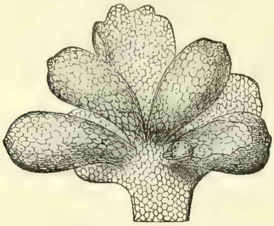
BIBL. Tul. *Fung. Hyp.* t. 21. f. 11; Berk. *Out.* tab. 21. f. 2; Cooke, *Handb.* p. 412.

SPHÆROCARPUS, Kütz. = STAUROCARPUS.

SPHÆROCARPUS, Mich.—A genus of Riccieæ (Hepaticæ). *S. terrestris* (fig. 658) is a minute Liverwort growing on the ground, especially, it is said, in clover-fields. The fronds are from 1-4 to 1-2" long, palish green, very thin and membranous, the lower surface adhering to the ground by radical hairs. The middle part of the upper surface bears a quantity of fruits, which consist at first of archegonia and antheridia, like those of other Liverworts, surrounded by a cup-like open perichæte (?), which gradually grows up over the fertilized archegonium and closes at the top, so as to form a pyriform sac, presenting an orifice at the summit. The archegonium ripens into a globular sporange, containing spores without elaters, crowned by a curious little styliform process. The spores are discharged by irregular rupture. The walls of the sporange are composed of simple parenchymatous cells, without spiral-fibrous layers. While the sporange is ripening, the perichæte enlarges into a loose, obconical, green, membranous

sac, through the thin walls of which the globular sporange is visible (fig. 658).

Fig. 658.



Sphærocarpus terrestris.
A frond with perichætes containing sporanges; one cut open.
Magnified 10 diameters.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 103; Bischoff, *Nova Acta*, xiii. p. 150; Lindenberg, *ibid.* xviii. p. 496; Fitt, *Hooker's Journ. of Bot.* vi. p. 287 (1847).

SPHÆROCOC'CUS, Stackh.—A genus of Rhodymeniaceæ (Florideous Algæ), containing one British species, *S. coronopifolius*, having a flat, linear, distichously branched frond of crimson colour and cartilaginous texture, of fan-like outline; parenchymatous, with an internal denser rib and cortical layer; 6 to 12″ long. The upper branches have their margins set with minute tooth-like processes, about 1-24″ long, in some of which the spherical conceptacles are imbedded.

Bibl. Harv. *Brit. Mar. Alg.* p. 128, pl. 16 B; Greville, *Alg. Brit.* pl. 15.

SPHÆROID'INA, D'Orb.—A roundish, sublobate, hyaline Foraminifer, near *Globigerina*, but of denser structure, and folded somewhat like a *Miliola*. Recent and fossil. *S. austriaca* (Pl. 47. fig. 4).

Bibl. Carpenter, *Introd. For.* 185.

SPHÆROM'PHALE.—A genus of Trypethelieæ (Angiocarpous Lichens), nearly related to *Verrucaria*.

SPHÆRONE'MA, Fr. — A genus of Sphæronemei (Coniomycetous Fungi), characterized chiefly by the spores which emerge from the pore becoming glued together into a firm globule. The species, which grow upon the surface of decaying plants, are probably only forms belonging to Sphæriaceous genera.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 281; *Ann. Nat. Hist.* vi. p. 363, *ibid.* 2nd ser. v. p. 371; Fries, *Summa Veget.* 400.

SPHÆRONEME'I.—A family of minute Coniomycetous Fungi, growing on bark, or more or less dry stems or leaves, characterized by the conceptacle ordinarily bursting by a pore or *ostiole*, or a lid, to extrude, in most cases, a gelatinous ball of filaments mixed with spores. From recent observations it appears that the genera of this order do not consist of independent species, but are forms which occur in combination with Ascomycetous forms to complete the whole development of an individual,—the Sphæronemeous genera constituting the stylosporous or conidial fruits of Sphæriacei, &c., corresponding perhaps to the tetraspores found in the Florideous Algæ, which also possess proper spores (see Sphæria).

Synopsis of British Genera.

1. *Coniothyrium.* Conceptacle free, membranous, opening by an irregular pore at the summit; spores globular.
2. *Leptostroma.* Conceptacle innate, subumbonate in the centre, dimidiate, at length falling off, leaving a very thin disk.
3. *Phoma.* Conceptacle ostiolate, very thin, innate, immersed, rounded, with a simple pore; spores oblong, simple.
4. *Leptothyrium.* Conceptacle operculate, innate, shield-shaped, not radiate-fibrous; spores spindle-shaped, simple.
5. *Actinothyrium.* Conceptacle operculate, innate, shield-shaped, radiate-fibrous; spores spindle-shaped, simple.
6. *Microthecium.* Conceptacle indehiscent, membranous, immersed, endophytic; spores simple.
7. *Cryptosporium.* Conceptacle membranous, opening irregularly at the summit; spores spindle-shaped, simple.
8. *Sphæronema.* Conceptacle horny, innate-superficial, more or less produced into a neck, ostiole simple; spores oblong, simple.
9. *Acrospermum.* Conceptacle leathery externally, fleshy within, elongate-clavate, ostiole simple; spores stick-shaped, simple.
10. *Diplodia.* Conceptacle horny, innate-superficial or immersed, perforated by a pore or irregularly opened or ostiolate, ostiole more or less produced; spores ovoid or ellipsoid, double, then halved into compressed-ternate semiellipsoid sporules.
11. *Hendersonia.* Conceptacle fleshy, superficially innate or immersed, perforated by a pore, opening irregularly or ostiolate, ostiole more or less produced; spores globose, cylindrical, or discoid.
12. *Septoria.* Conceptacle horny, innate-

immersed, rounded, ostiole simple; spores cylindrical, septate.

13. *Vermicularia.* Conceptacle bristly, depressed, bursting irregularly; spores minute linear.

14. *Neottiospora.* Conceptacles immersed; spores appendaged at one end with short hyaline threads.

15. *Prosthemium.* Conceptacle horny, immersed, ostiole simple; spores transversely septate, verticillate at the apex of their filaments.

16. *Asteroma.* Conceptacle very small, slightly prominent, close, subconfluent, seated on more or less distinct radiating fibrils.

17. *Angiopoma.* Conceptacles free, membranous, somewhat horny, cup-shaped, dehiscing by a circular mouth, provided with a fugacious epiphragm; spores affixed at the base, stalked, septate.

18. *Discosia.* Conceptacles innate, somewhat carbonaceous, at length collapsed and plicate, ostiole perforated; spores fusiform, produced at both ends into a thread-like point.

19. *Piggotia.* Conceptacles very irregular, thin, obsolete beneath, confluent into a rugulose patch, bursting by an irregular crack; spores on short stalks, largish, obovate, somewhat constricted towards the base.

20. *Phlyctæna.* Conceptacle spurious, formed by the blackened epidermis; spores fusiform, cuspidate, septate, emerging accompanied by a gelatinous mass.

21. *Glœosporium.* Conceptacle absent; spores covered only by the cuticle, which separates; spores stalked, longish, elliptical, simple, exuding a gelatinous tendril.

22. *Dilophosphora.* Conceptacle immersed in a spurious stroma, covered, perforated by a pore; spores cylindrical, continuous, crowned at both ends with radiating filiform appendages.

23. *Sphæropsis.* Conceptacle spherical, immersed, subinnate, astomous, at length (by the separation of the epidermis) bursting by circumscissile dehiscence or irregularly. Spores simple.

SPHÆROPHORE'Æ. — A family of Angiocarpous or closed-fruited Lichens, characterized by their apothecia formed in the swollen points of the thallus, bursting irregularly; containing the genus

SPHÆROPH'ORON. — *Thallus* erect, shrubby, externally crustaceo-cartilaginous, internally solid and cottony. Apothecia terminal, spherical, the perithecium, formed of the thallus, closed, dehiscing irregularly. Nucleus globular, internally floccoso-cartilaginous, the discharged (black) sporidia crowded in the circumference.

1. *S. coralloides* (fig. 395, p. 452) is not uncommon on sand-rocks, among mosses.

2. *S. compactum* is less common. The *spermogonia* have only been discovered as yet in the latter; they occur at the ends of the more delicate branchlets of the thallus.

BIBL. Hook. *Brit. Flor.* ii. pt. 1. p. 236; Leighton, *Brit. Angioc. Lichens*; Tulasne, *Ann. des Sc. Nat.* 3 sér. xviii. p. 209, pl. 15.

SPHÆROPH'RYA, Clap. et Lach.—A genus of Acinetina (Suctorial Infusoria).

Char. Suckers attached to the body separately, and not branched; there is no sheath to the body, and no peduncle; and the animal is a free swimmer.

S. pusilla is a small spherical Acinetinum, which exists in myriads with numberless *Oxytricha*, on which it feeds, in fresh water at Geneva.

BIBL. Clap. et Lach. *Etudes*, p. 385.

SPHÆROP'LEA, Ag.—A genus of Confervaceæ of uncertain position, but probably allied to the Chætophoraceæ. It is characterized chiefly by the formation of the spores. The plants consist of simple jointed filaments with long articulations, at first containing green colouring-matter excavated by large vacuoles, producing a banded appearance (Pl. 5. fig. 14 *a*), the contents finally resolving themselves in the fertile cells into numerous spinulose globular spores arranged in longitudinal rows (*b*), which become red when ripe.

The development of the spores of *S. annulina* has been observed by several authors; and Cohn has recently published an account of the formation of spermatozoids in distinct cells, exercising a fertilizing function. The filaments (which always terminate in pointed hair-like ends) present, when actively vegetating, the excavated or banded appearance of the green contents above noticed; the vacuoles separating the bands have a proper, colourless, mucilaginous coat. When about to produce spores the regularity of the bands vanishes, the vacuoles multiply in number in the substance of the bands, and the contents present the appearance of a green *froth* with starch-granules scattered through it. After a time a number of green corpuscles (the spores) appear in the median line of the cell; these assume a stellate shape, with radiating threads of protoplasm connecting them together; they soon appear in pairs, separated

by transverse false septa, formed by the flattened vesicles of the vacuoles. The spores gradually become better defined, and the false septa disappear; then the young spores present themselves as globular bodies, devoid at this time of a cellulose coat. From two to six minute orifices are perceptible at this time in the partially softened wall of the parent cell. While these phenomena are occurring in some of the cells, a different change takes place in others. The green bands assume a reddish-yellow colour, their starch disappears, and they are gradually converted into myriads of short stick-shaped bodies, which break apart and "swarm" in vast numbers, filling the whole cell, moving actively in all directions. The gelatinous coat of some of the vacuoles sometimes remains intact; and these then lie free in the cavity of the cell, and are often carried about by the rapid motion of the corpuscles. Orifices are meanwhile formed in these cells also, through which the thick-shaped bodies (spermatozoids) escape into the water. Their length is about 1-3000″. Their hinder end now appears somewhat swollen, and they bear two long cilia on the pointed beak—in fact resembling the *microgonidia* of the other Confervoids. Cohn states he has seen them accumulate around the orifices of the spore-cells, enter into the cavities of these, and swarm about in the interior, in considerable numbers, at length adhering to the young spores. These resting-spores then acquire a membrane, and under this a second, which is at first smooth, but afterwards presents a spinulose or stellate appearance; the first coat is then thrown off, and a third, smooth coat appears under the stellate coat, closely investing the contents. These conditions resemble those of the spores of SPIROGYRA and other Confervoids; *Spirogyra*, however, retains the outer coat until germination. The green contents of the spores ultimately turn red. Their size and number in a cell vary much.

Cohn has also observed the germination of these spores, which is interesting in several respects. Their ordinary size is from 1-1200 to 1-1500″; and they present, as above mentioned, two coats, the outer elegantly marked; most authors describe it as stellate; Kützing asserts that it is spirally folded. The real fact is, that it is plaited in the direction of 'meridians' from pole to pole, and thus appears stellate when seen at either pole, marked with lines when seen sideways. The spores do not appear to germinate until the spring following their production. The red contents begin to assume a green colour from the surface inwards, divided into two, then into four or eight portions, which break out from the spore-cell, and swim about as free biciliated zoospores, of globular or shortly cylindrical form, from 1-2280 to 1-1680″ long, either bright red or particoloured red and green, the point bearing the cilia, however, always colourless. After a time they become coated with a cellulose membrane, cease to move, and grow into a spindle-shaped body, the ends prolonged into hair-like points. The growth appears to be always in the middle, the hair-like points remaining; thus the spindle-shape is retained until the length reaches 1-24″ or more, and the first septum appears in the middle of the filament.

S. annulina (Pl. 5. fig. 14) appears to be the only well-known form. It is a rare Conferva, growing on flooded fields; it does not seem to have been recorded in Britain.

For *Sph. crispa* and *punctalis*, see ULOTHRIX.

BIBL. Kütz. *Sp. Alg.* p. 362, *Tab. Phyc.* iii. pl. 31; A. Braun, *Verjüngung, &c.* (*Ray Soc. Vol.* 1853, p. 165); Cohn, *Bericht. Berlin. Akad.* May 1855; *Ann. des Sc. Nat.* 4 sér. v. p. 187; *Ann. Nat. Hist.* 2 ser. viii. p. 81; Cienkowski, *Bot. Zeit.* xiii. p. 777; Rabenht. *Fl. Eur. Alg.* iii. p. 318.

SPHÆROPSIS, Lév.—A genus of Sphæronemei (Coniomycetous Fungi), growing upon stems, &c., apparently only stylosporous forms of Sphæriaceous genera.

BIBL. Fries, *Summa Veget.* p. 419; Tulasne, *Ann. des Sc. Nat.* 4 sér. v. p. 115.

SPHÆROSIRA, Ehr. See VOLVOX.

SPHÆROT'ILUS.—A doubtful genus allied to *Leptothrix*.

BIBL. Rabenht. *Fl. Eur. Alg.* ii. p. 8.

SPHÆROZOS'MA, Corda.—A genus of Desmidiaceæ.

Char. Filamentous; filaments flat, fragile, their component cells closely united by means of minute (glandular) processes, and deeply divided on each side into two segments.

1. *S. vertebratum* (Pl. 10. fig. 9, front view; fig. 10, side view). Cells about as long as broad; connecting processes oblique, one on each side. Length of cell 1-1430″.

Not uncommon.

2. *S. excavatum.* Cells longer than broad; connecting processes sessile, two on each side. Length of cell 1-2570″.

After separation the cells conjugate; sporangia elliptical.

BIBL. Ralfs, *Brit. Desmid.* p. 65; Rabenht. *Fl. Eur. Alg.* iii. p. 148.

SPHÆROZO'ÜM.—A genus of Thalassicollida (Radiolaria).

It consists of a number of spherical bodies consisting of sarcode and distinct nuclei, surrounded by a zone of siliceous spicules, the whole being imbedded in a common gelatinous matrix. The centre of the mass is vacuolated; and the whole often becomes a hollow sphere.

BIBL. Huxley, *Elem. Comp. Anat.*; Carpenter, *The Microscope.*

SPHÆROZ'YGA, Agardh (*Anabæna*, Bory, Brébisson).—A genus of Nostochaceæ, differing from the allied genera only in the microscopic characters of the filaments, the sporangial cells being separated by vesicular cells. As the sporangial cells are developed from the ordinary cells, and this gradually, the vesicular cell will appear at certain epochs to have a sporangial cell on one side and an ordinary cell on the other; but this arises merely from the fact that the sporangial cells are developed singly and successively, first one on one side of the vesicular cell and then one on the other, and so on, to whatever number of adjacent sporangial cells there may be developed on either side of the vesicular cell; and those nearest the latter will therefore always be the largest, until the whole have acquired the full size. Ralfs describes seven British species.

* *Filaments moniliform; sporangia elongated, not turgid.*

1. *S. Carmichaelii*, Harvey.—Filaments with tapering extremities; ordinary joints distinct, subquadrate; sporangial cells oblong; vesicular cells spherical.—Ralfs, *Ann. Nat. Hist.* 2 ser. v. pl. 8. fig. 7; Harvey, *Phyc. Brit.* pl. 113 A; *Brit. Mar. Algæ*, 2nd ed. pl. 27. fig. D.

Belonia torulosa, Carmichael; *Sphærozyga compacta*, Kützing, *Phyc. Generalis*; *Anabæna marina*, Brébisson; *Cylindrospermum Carmichaelii*, Kützing, *Sp. Alg.* 294, *Tab. Phyc.* i. pl. 99.

Var. *tenuissima*, with very slender filaments. Forming a tender, very thin stratum of a dark or bluish-green colour, on the damp soil of salt-marshes flooded at spring-tides, more rarely in brackish ditches or upon decaying marine Algæ.

The best distinctive marks of this species are the "subacute extremities, combined with the short filament and littoral habit."

2. *S. Jacobi*, Agardh.—Filaments elongated, their ends usually attenuated; ordinary cells subspherical; vesicular cells spherical; sporangial cells oblong or cylindrical. —Ralfs, *l. c.* pl. 8. fig. 8; *Eng. Bot.* 2826. fig. 2. Forming thick, bluish-green, gelatinous masses, from which the filaments issue in long rays. Fresh water.

3. *S. elastica*, Agardh.—Dissepiments conspicuous; ordinary cells quadrate; vesicular cells elliptic; sporangial cells cylindrical, truncate.—Ralfs, *l. c.* pl. 8. fig. 9. *Cylindrospermum elongatum*, Kütz. *Tab. Phyc.* i. pl. 99. fig. 3. Forming a tender stratum, of a deep bluish colour, in bogs.

** *Filaments moniliform; sporangia turgid, much broader than the ordinary cells.*

4. *S. Broomei*, Thwaites.—Filaments elongated; ordinary cells suborbicular; vesicular cells barrel-shaped or elliptic; sporangial cells elliptic, catenate.—Ralfs, *l. c.* pl. 7. fig. 10. Forming a firmish bluish- or yellowish-green stratum in brackish ditches.

5. *S. Berkeleyana*, Thwaites.—Ordinary cells spherical or slightly compressed; vesicular cells spheroidal, compressed, as broad as the large, turgid-elliptic, sporangial cells. —Ralfs, *l. c.* pl. 8. fig. 11. In brackish ditches.

6. *S. Mooreana*, Ralfs.—Ordinary cells subspherical; vesicular cells barrel-shaped, much narrower than the large, broadly elliptical sporangial cells.—Ralfs, *l. c.* pl. 8. fig. 12. An Irish species.

*** *Dissepiments obscure; cells longer than broad.*

7. *S. leptosperma* (Kützing).—Filaments elongated, not constricted at the dissepiments; ordinary cells longer than broad, confluent; vesicular cells elliptic; sporangial cells linear.—Ralfs, *l. c.* pl. 8. fig. 13. *Cylindrospermum leptospermum*, Kützing, *Tab. Phyc.* i. pl. 99. fig. 2. Forming large shapeless gelatinous masses in still waters, varying from deep green to yellowish green, or, when the filaments are comparatively few, nearly colourless. Distinguished especially by the "confluent ordinary cells with obscure dissepiments."

BIBL. As above.

SPHAGNA'CEÆ.—A family of Cladocarpous Mosses, of peculiar habit, growing on bogs, &c., distinguished especially by the mode of branching, the structure of the

leaves, sporanges, and antheridia, and by the absence of roots, except in the early stages of growth.

The stem of the *Sphagna* is composed of three layers of cells,—a cortical, a medullary, and a prosenchymatous layer intermediate, which finally becomes somewhat woody. The primary axis is indefinite in its growth; the lateral axes, sterile or fertile, are annual. The secondary axes are fasciculate; and being pendent or recurved upon the stem, they fulfil in some measure the function of roots. The leaves are remarkable for the cellular structure, being composed of two kinds of cells—namely, narrow and elongated cells filled with chlorophyll, conjoined into a kind of network, the meshes of which are occupied by large hyaline cells. The hyaline cells contain, in all but one exotic species, a spiral or annular secondary deposit (Pl. 39. fig. 25) characteristic of this family. These large cells also become opened by regular circular pores at a certain stage of growth.

The inflorescence is monœcious or diœcious. The antheridia are produced singly in the axils of perigonial leaves at the club-shaped tips of short branches. They are pedicellate and roundish, like those of the Liverworts; they produce biciliated spermatozoids. The archegonia are found about four together, sessile, in a tuft of perichætial leaves occupying the axis of a fascicle of branches, the receptacle subsequently elongating into a peduncle, bearing a globular capsule, entirely surrounded by the calyptra; the calyptra is ruptured near the middle, the lower part persistent and continuous with the fleshy vaginule, within which the capsule is seated on a bulb-like pedicel; peristome none; operculum flattish, thrown off with elasticity. Spore-sac wanting; columella short, not reaching the mouth of the capsule. Spores apparently of two kinds, some enclosed four together in parent cells, others smaller, sixteen in one mother cell; the former fertile, the latter sterile, occurring either together or in distinct capsules. The spores in germinating produce a Marchantioid body, very different from the confervoid mass of ordinary mosses.

British Genus.

Sphagnum, Dill. Character that of the order. Nine species occur in Britain, some common on every bog, distinguished by their brilliant yellow-green colour and the wet, spongy character of the beds they form. The leaves are very interesting microscopic objects.

Bibl. Wilson, *Bryologia Brit.* p. 14; Schimper, *Ann. des Sc. Nat.* 4 sér. i. p. 313.

SPHAGNOCŒ'TIS, Nees.—A genus of Jungermannieæ (Hepaticæ), containing one species, *S.* (*Jung.*) *Sphagni*, an elegant little plant growing over *Sphagnum* and other mosses on bogs; attaching itself by long radicles, numerous on the under side of the procumbent, nearly simple stem. The gemmiferous branches only have amphigastria.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 113; *Brit. Jung.* pl. 33, and Suppl. pl. 2; Ekart, *Syn. Jung.* pl. 6. figs. 43 & 48.

SPHENEL'LA, Kütz.—A genus of Diatomaceæ.

This genus appears to consist of the detached frustules of *Gomphonema.*

Kützing describes seven species.

S. vulgaris (Pl. 14. fig. 19).

Bibl. Kütz. *Bacill.* 83, and *Sp. Alg.* 62; Rabenht. *Fl. Eur. Alg.* i. p. 282.

SPHENODE'RIA, Schlum.—A doubtful genus of Arcellina (Rhizopoda).

It is allied to *Euglyphe* and *Trinema.*

Bibl. Pritchard, *Infusoria*, p. 557.

SPHENOSI'RA, Ehr., Kütz.—A genus of freshwater Diatomaceæ. Diatomaceæ, p. 244.

S. catena (Pl. 13. fig. 26).

Bibl. Kützing, *Sp. Alg.* 68; Rabenht. *Fl. Eur. Alg.* i. p. 293.

SPHINCTOCYS'TIS, Hass. (*Cymatopleura*, Sm.). A genus of Diatomaceæ.

Char. Frustules free, single; in front view linear, with undulate margins; valves oblong or elliptical, sometimes constricted in the middle. Aquatic.

Valves with coarse, transverse or nearly transverse, rounded elevations appearing as dark bands, an interrupted median line, coarse marginal dots and transverse striæ, but neither alæ nor nodules.

Several British species.

1. *S. solea* (Pl. 12. fig. 23). Valves linear-elliptic, narrowed on each side towards the middle, transverse striæ evident; extreme length 1-216″.

Undulations six. Common.

β. Much shorter, undulations four, ends apiculate.

2. *S. elliptica* (Pl. 12. fig. 24). Valves broadly elliptic or elliptic-oblong, striæ obscure, undulations four or five; length 1-280″.

Common.

3. *S. hibernica.* Valves broadly elliptic,

acuminate, undulations three; length 1-250''.

Bibl. Hassall, *Brit. Freshw. Algæ*, 436; Smith, *Brit. Diat.* i. 36; Kützing, *Sp. Alg.*

SPHINCTRI'NA.—A genus of Calycieæ (Gymnocarpous Lichens), with little stalk-like excipula and scarcely distinguishable thallus, growing on leaves or on other Lichens. Some of the species seem to be Fungi, being destitute of any crust.

Bibl. Leighton, *Ann. Nat. Hist.* 2 ser. xix. p. 132; *Brit. Lich. Fl.*

SPICULA (plural of *spiculum*).—In some of the lower Invertebrata, firmness is given to the body by a kind of internal and external skeleton consisting of a number of curiously shaped microscopic bodies, many of which are of a needle-like form, often containing a cavity, and denominated spicula. They are met with in endless variety of form in sponges (see Spongida) (Pl. 36, the lettered objects), where they usually consist of silex, some being of carbonate of lime. They also occur as anchors and plates in Synapta (Pl. 36. figs. 1 *h*, *i*, *k*, *l*, and 19 *a*, *b*, *c*), the Foraminifera (Pl. 18. fig. 24), and in some of the Actinida (*Alcyonium*) and Mollusca (*Doris*), in these instances being calcareous.

There can scarcely be doubt that spicula are homologous with the elements of shell; but little or nothing is known of their development.

Spicula form very interesting microscopic objects, on account of their remarkable forms.

To prepare them, the animal substance in which they are contained should be boiled with nitric acid if they are composed of silex, and with dilute solution of potash if they consist of lime-salts. They may be preserved by mounting in Canada balsam.

They are commonly met with in sea-mud; and as fossils in some rocks.

SPIDERS. See Arachnida and Araneida, and for Red Spider, Gamasus.

SPILOCÆA, Fr.—A genus of Torulacei (Coniomycetous Fungi). *S. Pomi* occurs upon apples, in contiguous effused patches, from which the epidermis separates in fragments, exposing the simple globular spores, adherent to each other and to the matrix.

Probably only a state of *Cladosporium*.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 360; Fries, *Summa Veget.* p. 482.

SPILONE'MA, Born.—A genus of Collemacei (Lichens).

Char. Thallus filiform, branched, fruticulose, granula gonima large, in transverse strata. Apothecia lecideine, lenticular. Spermatia shortly cylindrical.

Bibl. Leighton, *Brit. Lich. Flora*, p. 11.

SPINAL CORD.—The spinal cord of man is that part of the central nervous system which extends downwards from the medulla oblongata, occupies much of the vertebral canal, and terminates in a conical extremity at the level of the first lumbar vertebra. Its general anatomy may be studied in all the later works on human anatomy, and that of the cord of other vertebrata in most works on comparative anatomy and physiology. The cord is composed of white substance, grey substance, connective tissue, and blood-vessels; and their histology and mutual relations come within the scope of the microscopist. The white substance is mostly external, and forms the antero-lateral and posterior longitudinal columns, besides the transverse anterior commissure at the end of the anterior longitudinal fissure. It is composed of nerve-fibres of large and medium size, of connective tissue, and blood-vessels. The grey substance is internal, and in transverse sections of the cord presents a shape which may be roughly compared with that of the letter "H." On either side there is an anterior and posterior horn or cornu; and the median line of the letter is represented in nature by a soft grey commissure perforated by a canal, which is central and lined with epithelium. Surrounded on all sides by the white substance, the anterior and posterior spinal nerves reach their respective cornua by crossing at different angles along two lines on either side of the general direction of the nerves of the white substance. The grey substance contains a large quantity of very fine nerve-fibres, which are united in a plexiform manner with nerve- or ganglion-cells; most of these fibres pass outwards and become spinal nerves, belonging then to the white substance or to distinct nerves. There are moreover an amount of granular matter, highly refractive globules, and extremely small nucleated cells surrounding the nerve-fibres and ganglion-cells, and also capillaries. Much connective tissue exists in the neighbourhood of the central canal and in the posterior cornu (see Pl. 48).

The white substance.—The white substance of the spinal cord is invested by a layer of connective tissue belonging to the pia mater; and this layer is continued into

the substance in the form of a matrix which encloses the nerve-fibres in its meshes. Moreover the layer passes down the anterior fissure as a fold, and as a simple prolongation down the posterior fissure. There are also large prolongations in the midst of the antero-lateral column towards the grey substance. The matrix consists of various-sized trabeculæ enclosing meshes of different calibres, in which run the nerves. Capillaries pass along the trabeculæ, whose fibrillæ are accompanied by a slight amount of elastic fibre and by a cellular element, part of which consists of ordinary connective-tissue cells with branches, and the rest of cells whose nuclei are stained readily with carmine after hardening in solution of chromic acid. Each mesh or space included by the trabeculæ contains a nerve-fibre, which is medullated, and has a large axis-cylinder but no tubular membrane; and between the nerve and the fibrils there is a peculiar tissue, often finely granular and even fibroid in its appearance, which may be a modification of connective tissue, or possibly only an appearance produced in homogeneous protoplasm by chemical re-agents; for it is not visible in many excellent sections. Some histologists have observed elastic fibres in this pseudo-tissue, and it is generally termed neuroglia; on the other hand, it may be a modification of the tubular membrane which should surround the medullated nerve. The diameter of the nerve-fibres of the white substance of the cord is not constant, and the thickest fibres are found in the anterior columns close to the anterior fissure; and, as a rule, the most delicate nerves are central, and near the grey matter. Some observers have noticed bifurcation of the nerve-fibres in the white substance. Vertical fibres are the commonest, and constitute the bulk of the several columns, they are closely applied and are often in bundles, the matrix intervening. Horizontal fibres are found in the anterior commissure, where they unite the nervous elements of the two anterior cornua. Other horizontal fibres occur in the median portions of the lateral columns close to the grey matter; but after pursuing this course for a short distance they merge into the vertical series, which constitutes the bulk of the antero-lateral part of the white substance of the cord. The nerves which enter the front part of the cord, and which traverse the white substance to enter the grey matter, usually pass more or less horizontally or slightly obliquely inwards and originate in connexion with ganglion-cells. But the posterior nerves in passing towards the posterior cornu divide into three groups: some pass inwards horizontally; others pass upwards obliquely and then turn inwards, whilst the rest pass downwards and then obliquely to end in the posterior cornu.

Grey substance.—The connective tissue or neuroglia is abundantly present in the grey substance—that is to say, if all the cellular elements which are not well developed multipolar cells are to be considered only those of connective tissue. The fibrillar structure peculiar to the trabeculæ of the matrix of the white substance is lost, and merges into the granular and cellular structures considered by some to be neuroglia, and by others true nervous matter. Around the central canal there is evidently a fibrillated connective tissue, and in the posterior horn also (the substantia gelatinosa). But in examining this important part of the cord, it must be remembered that all hardening agents, except freezing, tend to destroy vast numbers of small cells, and that the action of the clearing reagents evidently destroys much of the tissue. The proof of this may be gleaned by comparing the diameter of prepared and unprepared transverse sections of the human spinal cord. In prepared specimens it will be observed that the nerve-fibres of the grey substance form its chief constituent. Some are medullated; but the majority are simple axis-cylinders and protoplasmic processes of the multipolar cells, and all divide and subdivide so as to become extremely attenuated and to form plexuses. Thus the multipolar or ganglion-cells have two or more processes, which branch; and then the ramifications branch and rebranch, joining those of other cells or the plexiform origins of the axis-cylinders. The ganglion-cells (see NERVES) do not appear to have a cell-wall, and contain large nuclei with one or more nucleoli, besides pigment generally diffused or in granular masses. Every variety of form may be present; and their size is from 0·12 mm. downwards. The largest cells occur in the anterior and the smallest in the posterior cornua, whilst those of Clarke's columns, which are situated laterally and behind the region of the central canal, are mostly fusiform, with their long axes placed vertically. The multipolar cells are frequently seen to be in the immediate neigh-

bourhood of a tissueless spot. Their processes in some are of two kinds, as has already been mentioned (see NERVES). One is long and not divided, and becomes an axis-cylinder, being covered with the medullary sheath as it becomes a true spinal nerve; and the others divide and subdivide, as has been mentioned above. In other cells the long axis-cylinder process is deficient, and the short projections alone exist and join those of other cells. Finally, a group of cells may have its processes ramifying and joining the terminal plexus of an axis-cylinder.

The posterior or grey commissure.—This is situated transversely and horizontally, and reaches from the back of the anterior commissure to the end of the posterior fissure. It consists, from before backwards, of anterior nerve-fibres crossing from one anterior cornua to the other, and then of a wide space, in which there is a plexiform arrangement of fibrils surrounding the central canal. This is more or less circular in outline, and consists of a cylinder of connective tissue lined internally by columnar epithelium, which under certain circumstances is ciliated. There is a central open space, which doubtless during life contains fluid. The columnar cells have, under certain reagents, such as solution of chromic acid, fibrillar-looking appendages surrounded by a finely granular matter on their end remote from the cilia. Behind the canal is the posterior part of the grey commissure, consisting of nerve-fibres and connective tissue, the nerves passing from one posterior cornu to the other.

Gerlach states that the multipolar cells of the anterior cornua originate nerve-fibrils, which are continuous with a large process of each cell, but that the processes of the cells of the posterior cornua break up into the plexiform arrangement, whence the posterior nerves arise.

Methods of preparation. — The general principles of preparing and making sections of nervous tissue have been noticed under PREPARATION; and see also STAINING. The following references will enable microscopists to select a variety of methods. Hardening with bichromate of ammonia and staining with double chloride of potassium and gold (Gerlach in Stricker, 'Hum. & Comp. Hist.' tr. Power, vii. p. 344). Hardening with bichromate of ammonia, and staining with carmine and ammonia, teasing and clearing in glycerine or Canada balsam (ibid. p. 345). Solutions of chromic acid, bichromate of potash, spirit of wine, staining with carmine and ammonia. Clearing with turpentine and Canada balsam (Lockhart Clarke in Beale, 'How to Work,' 4th edit. p. 145). See also the last method described under article PREPARATION.

BIBL. Todd's *Cycl. Anat. & Phys.* art. *Nerve and Spinal Cord*; Stilling, *Rückenmarkes*, Cassel, 1857; Lockhart Clarke in *Phil. Trans. Roy. Soc.* 1858, 1868, *Qu. Mic. Jn.* iii. p. 66; Kölliker, *Handb. d. Gewebel.* 5th edit.; Deiters, *Untersuch. ü. Gehirn u. Rückenmark*, ed. by Max Schultze, 1868; Gerlach, *Anat. d. mensch. Rückenmarks, Med. Centralb.* Jahrg. 1867, no. 24; and in Stricker's *Hum. & Comp. Hist.* ii.

SPINES OF ANIMALS.—These are properly stout rigid and pointed processes of the integument, formed externally by the epidermis, and internally of a portion of the cutis or corresponding structure; but the term is frequently applied to stout rigid and pointed processes of the epidermis only.

See HAIRS, and the notices of the structure of the integument under the heads of the various classes.

Echinus-spines, see SHELL.

SPIRACLES or STIGMATA of animals. —The external orifices of the tracheæ of Insects and Arachnida. The respiratory tubes of these animals have no communication with the mouth, but terminate externally in orifices situated upon the surface of the thorax or abdomen. These are mostly rounded or elliptical (Pl. 28. figs. 3, 7, 8, and 9 *a*), sometimes in the form of small clefts, and are often furnished with a kind of movable valve, or bounded by a thickened rim; sometimes a sieve-like structure (Pl. 27. fig. 34) prevents the admission of foreign bodies, or they are surrounded by hairs or scales effecting the same purpose.

They are often situated at the lateral and upper portions of the abdomen, at the posterior, lateral, and upper part of the thorax, &c.

See ARACHNIDA, INSECTS, and the heads of the genera.

SPIRAL STRUCTURES OF PLANTS.—Among the most elegant of the microscopic objects furnished by the Vegetable Kingdom are the various forms of the secondary deposits upon the walls of cells, vessels, and ducts, &c., which present the appearance of fibres coiled into perfect spirals, or of spiral fibres either with the coils detached and forming rings, or with the coils more or less

connected by cross pieces, producing a reticulated structure.

Under the head of SECONDARY DEPOSITS it is stated that this spiral-fibrous deposit may be taken as the character of a group of structures to be contrasted with those structures described as PITTED, and that the essential distinction in the nature of these two groups lies in the greater extent to which the primary wall is covered in the pitted structures. This is not quite absolute in reference to all spiral-fibrous structures, as in the true unrollable spiral vessels and similar organs the coils of the spiral fibres are often closely in contact, although not adherent to each other. It has been stated that the various forms of the open spiral, annular, and reticulated deposits are modifications of the simple close spiral; but this must be understood only in a morphological sense, since there is no actual change of condition ensuing with age, as has been assumed by some authors, the fibrous layers being always originally deposited on the primary wall in the form and pattern which they ultimately possess. There appears to be no real opening of the spirals, or breaking up into rings, in consequence of the expansion of the primary wall to which they are attached.

It will be convenient, in the first place, to speak of the distinct well-marked structures ordinarily known as spiral cells and vessels, occurring in the stems, leaves, &c. of the higher plants, before describing certain other forms found in special organs, and to reserve to the end some points relating to the ultimate constitution of the secondary membranes of cells. Spiral structures are usually divided into *true spiral*, *annular*, *reticulated*, and *scalariform* organs.

Spiral cells and vessels are perhaps the most generally diffused of the forms. The name spiral vessel is given to elongated cylindrical cells tapering to a point at both ends, with a spiral-fibrous deposit lining the primary wall (fig. 659, and Pl. 39. figs. 8, 11, 12). The spiral fibre may be either single, as is most common, double (fig. 659); or a number of fibres may run parallel (*Musa, Nepenthes, Zingiberaceæ, Marantaceæ*). These spiral vessels occur as the first vascular formation outside the pith (MEDULLARY SHEATH) in almost all the Dicotyledons (fig. 660), and as the first vascular formation in the vascular bundles of the stems of Monocotyledons—also of all other vascular bundles, forming the ribs or veins of petioles, leaves, bracts, sepals, petals, &c. In the internal organs they can only be observed in sections, or when extracted by maceration; in delicate vessels and petals they may often be observed through the transparent epidermis. The coiled spiral fibre is mostly elastic enough to bear

Fig. 659.

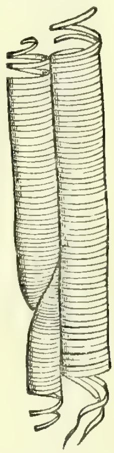


Fig. 660.

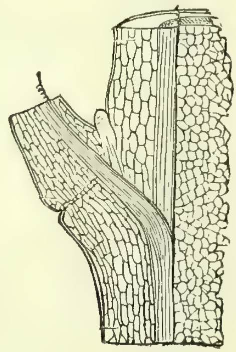


Fig. 659. Fragments of spiral vessels from the Melon. Magnified 200 diameters.

Fig. 660. Magnified diagram of a section of the base of a leaf-stalk arising from a Dicotyledonous shoot, showing the position of the spiral vessels in the leaf-stalk and next the pith of the shoot, the spiral fibres being uncoiled and a little drawn out.

stretching open like a wire spring; in this case the primary wall is torn between the coils, and its ragged edges may sometimes be detected. The uncoiled fibres are often seen still unbroken when a hyacinth or similar leaf is broken across and the pieces gently drawn apart. *Annular* vessels closely resemble the preceding, except that the fibrous deposits are in the form of detached rings (fig. 661); they are the rarest forms; they are especially remarkable in the Equisetaceæ. The *reticulated*, again, have irregular spiral coils or rings connected more or less by perpendicular or oblique bars (fig. 662, and Pl. 39. fig. 9) into a network. These two modifications are usually of larger diameter than the true spiral vessel, and the reticulated larger (also of later origin in the organs) than the annular. However, mixed forms occur not uncommonly, partly annular, partly spiral or reticulated (fig. 663). They are found in similar situations, but generally do not extend into the more de-

licate organs. Spiral, annular, and reticulated vessels may be prepared in most beautiful forms and large size from portions of the leaf-stalk of rhubarb, of the stem of the garden-balsam, the melon, &c.

Fig. 661.

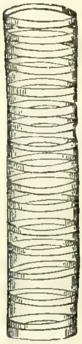


Fig. 662.

Fig. 663.

Fig. 661. Fragment of an annular vessel from the Melon. Magnified 200 diameters.

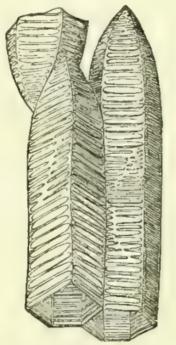
Fig. 662. Portion of a reticulated vessel from the Melon. Magnified 200 diameters.

Fig. 663. Fragment of a spiral and annular vessel from he Melon. Magnified 200 diameters.

Spiral and other vessels are usually simple at first (branched *spiral* vessels do occur, more rarely), but ordinarily unite together by a kind of fusion. The conical extremities overlap to a certain extent (fig. 659); and thus the articulation is more or less oblique. This fusion is much more evident and complicated in roots, rhizomes, and abbreviated stems than in stems with developed internodes. The elementary cells are then generally much shorter; and the vessels formed from them branch out in various directions through the tissue. This is very well seen in the roots of many herbaceous plants, such as the dandelion, chicory, &c., and at the point of origin of the vascular bundles of adventitious roots generally.

The above-mentioned confluent spiral vessels pass insensibly into the *ducts*, which are similar confluent rows of cells forming parts of the solid wood of stems, composed of cells with flat ends applied together. They may resemble in their markings the preceding forms, but in their varied conditions form a series leading towards the PITTED DUCTS. The *scalariform* vessels or ducts (fig. 664, and Pl. 39. fig. 10), so called from the ladder-like markings, are a very regular form of the reticulated type—this regularity appearing to depend, however, upon the relation between the markings of the adjacent organs. In the PITTED DUCTS we find the pits only opposite to other pits, therefore on the sides adjacent to other ducts or to cells; in the scalariform ducts a spiral-fibrous deposit is conjoined into a network by vertical fibres placed opposite the intercellular passages or the meeting angles of contiguous cells or ducts, leaving regular slit-like spaces opposite the cavities of the adjacent cells. This form is especially characteristic of the Ferns; but it occurs also commonly in the Dicotyledons in a less regular form, passing quite insensibly into PITTED DUCTS, as in the wood of *Eryngium maritimum* (Pl. 39. fig. 21). The scalariform vessels of Ferns are often slightly unrollable.

Fig. 664.



Fragments of scalariform vessels from a Fern. Magnified 200 diameters.

It is mentioned under PITTED STRUCTURES, also, that a combination of the two types sometimes occurs in the same cell. This is the case in the ducts of the Lime, Mezereon, and other plants (Pl. 39. figs. 4, 13, & 19).

Besides the generally diffused spiral and other vessels and ducts above described, cells, properly so called (that is, such as never become elongated very greatly in one particular direction), belonging to particular organs and plants, present the same kind of markings. The ducts and vessels, indeed, in many cases are formed of very short cellular elements; but these may be distinguished from proper cellular tissue characterized by spiral secondary deposits. Under this head may be cited first certain *wood-cells*. In the Cactaceæ, the prosenchymatous tissue of the stem presents remarkable spiral and annular cells, in which the fibre becomes so much thickened that it projects like a riband set with its edge against the cell-wall (Pl. 39. fig. 7). The wood of the Mistletoe (figs. 665, 666) also exhibits spiral-fibrous cells; that of the Yew (TAXUS) is composed of true spiral-fibrous cells and others with bordered PITS and an internal spiral fibre in addition (Pl. 39. fig. 4). In the stems of the Leguminosæ, parenchymatous portions occur in the midst of the wood, the cells of which exhibit spiral fibres

(*Ulex*, *Spartium*). The cellular tissue near the surface of the roots of the epiphytic Orchids (Pl. 39. fig. 6) affords another example, as also some of the subepidermal cells of the leaves (fig. 667). The layers of

Fig. 665.

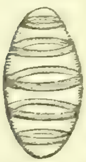


Fig. 666.

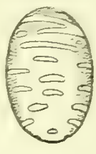


Fig. 667.

Fig. 665. Annular-fibrous cell from the stem of Mistletoe. Magnified 200 diameters.

Fig. 666. Cell intermediate between reticulated and pitted, from the Mistletoe. Magnified 200 diameters.

Fig. 667. Spiral-fibrous cell from the leaf of an Orchid. Magnified 200 diameters.

cells lining the ANTHERS of Flowering plants are characterized by most varied patterns of spiral markings (Pl. 32. figs. 1–5); in these cells, moreover, we sometimes see the connexion between the fibrous and homogeneous deposits well illustrated, as the cells may have one or more sides marked with spiral fibres, while the remainder of the wall is covered with a continuous layer. A similar structure, generally with perfect spiral fibres, occurs in the walls of the sporanges of *Jungermannia*, *Marchantia* (Pl. 32. fig. 35), and other Liverworts. With these are nearly connected the structures called ELATERS, which are found mixed with the spores in the same plants. These are tubular cells containing a single or double elastic spiral fibre (Pl. 32. figs. 36–38), exactly analogous to the spiral vessel in structure. Elaters of similar nature occur even among the Fungi, as in the sporange of TRICHIA (Pl. 32. figs. 39, 40). The elaters of the Equisetaceæ (fig. 205, p. 288) are of different character, consisting of four short filaments with clavate ends, attached at one side of the spore and originally coiled round it, ultimately unrolling with elasticity. They appear to be formed by the deposition of a spiral-fibrous layer on the wall of the parent cell of the spore, within which the true (single) spore-membrane is formed, unadherent; and when the spore is ripe, the spiral-fibrous layer splits up and starts away from the inner coat. An elegant spiral and annular fibrous structure is also met with in the large cells of the leaves of the SPHAGNACEÆ (Pl. 39. fig. 25); this is exactly analogous to the similar deposits in the higher plants. Spiral layers are found, less distinctly, in the radical hairs growing from the lower surface of the frond of MARCHANTIA. Nägeli regards them as folds of an inner layer of membrane; but they appear to be regular secondary deposits.

Lastly, the hairs and similar epidermal appendages sometimes exhibit spiral-fibrous deposits. An unrollable spiral fibre is beautifully arranged in the cells forming the mealy coating of the seed of *Cobæa scandens* (Pl. 21. fig. 20). The seeds of many of the Acanthaceæ (Pl. 21. figs. 21 & 24), *Collomia* (Pl. 21. fig. 22), the pericarp of some of the Labiatæ (Pl. 21. fig. 23) and Compositæ (SENECIO) bear tubular hairs, consisting of cells with a spiral or annular fibre in their interior (see HAIRS of Plants). The structure of the hairs of *Collomia*, *Ruellia*, &c. has been much discussed, but it seems very simple: they appear to consist of a short tubular cell, upon the wall of which a closely coiled elastic spiral-fibrous layer is deposited; during the ripening of the seed the primary membrane undergoes a metamorphosis into a substance related to amyloid (or bassorin?), which softens and swells up when placed in water, allowing the spiral fibre to extend itself (Pl. 21. figs. 21, 22 *b*, *c*). Sulphuric acid and iodine give the swollen gum-like envelope a purplish tint.

Another and less distinctly marked spiral arrangement of the substance of the cell-walls occurs in the form of cracks or gaps in certain of the layers of the secondary deposits, running more or less round the cell, appearing like irregular spiral streaks; these are sometimes present in the earlier secondary layers and not in the later, so that the "cracks" are covered in by the latter and converted into canals in the substance of the cell-wall. These occur in the wood-cells of *Hernandia sonora*, in the prosenchymatous cells of the vascular bundles of *Caryota urens*, *Phœnix*, *Metroxylon*, and probably in other cases. Something similar may be detected in the wood-cells of *Pinus* (Pl. 39. fig. 1), especially after treatment with boiling nitric acid. In liber-cells a spiral texture is far more generally evident. In *Vinca*, for instance (Pl. 39. fig. 30), and other Apocynaceous plants, a delicate spiral striation of the wall is evident in its natural state, beautifully regular in its arrangement; a similar appearance may often be detected in the walls of thickened hairs, especially when acids are applied, as in

Cotton (Pl. 21. fig. 1 *b*), particularly in gun-cotton (fig. 1 *c*)—sometimes with intermediate slits, as in *Urtica* (Pl. 21. fig. 8), &c.; and by boiling with nitric acid, a minute spiral-fibrous structure may be detected in the secondary layers of the liber-cells of very many plants, as of Flax (Pl. 21. fig. 2 *b, c*), Coir (Pl. 21. fig. 5 *a, b*), *Bœhmeria* (Pl. 21. fig. 2 *b, c*), &c. All these spiral structures belong to the secondary deposits of the cells; they are mostly distinguishable from those previously described by being *thinner places* or *lines left bare*, instead of being *lines of deposit*.

We have observed a somewhat similar spiral streaking of the walls of *Hydrodictyon*, depending on slits in certain of the laminæ. Some of the genera of Oscillatoriaceæ, as *Ainactis* (Pl. 4. fig. 15 *b*) and *Schizosiphon* (Pl. 4. fig. 13 *d, e*), also present a spiral-fibrous decomposition of their cellulose coats when old; and we have seen a spiral marking on the wall of *Cladophora*, as described by Mitscherlich. Agardh has recently stated that he detected a complicated spiral-fibrous structure in the cell-wall of Confervæ, extending, however, from one cell to another; and he regards this as a proof of the spiral structure of *primary* cell-membrane generally; and he says he has likewise detected an analogous spiral-fibrous structure in the primary cell-wall of the structures of the Phanerogamia. The delicate striation of the membranes of the Confervæ and slightly thickened liber- or parenchyma-cells of many Flowering plants form a desirable object of investigation for those accustomed to the delicate observation of the markings of the valves of the Diatomaceæ. The use of reagents, such as nitric acid and solution of potash, boiling, maceration, and other means must be employed for this purpose, controlled always by a careful observation of the structures in their natural state and in different stages of development. It is not impossible that all secondary deposits may prove, as Meyen assumed, to have a fibrous constitution, and true *membrane* to be confined to the primary walls. One set of layers, however, seems always to resist the endeavour to resolve them into fibrils, namely those of the horny and fleshy ALBUMEN of seeds.

As to the mode of the formation of spiral secondary deposits, little is certainly known at present. Crüger attributes them to spiral circulation of the secreting protoplasm over the cell-wall in the position of the future fibres. We believe this to be a somewhat speculative notion. Others have asserted that they are formed by gradual collocation of visible granules; this is certainly an error. We have observed the gradual formation of the spiral band in the elater of *Marchantia*, where it is at first a faint spiral trace with indistinct edges; as it grows thicker, the edges become more and more defined, and it is produced originally in the exact position and pattern which it subsequently retains. Trécul has lately published an elaborate memoir, reviving an old notion that the spiral and other fibrous markings are folds of membrane thrown inwards from the cell-wall. We believe this to be altogether a misconception.

The actively moving spiral filaments or SPERMATOZOIDS of the Ferns, Mosses, Characeæ, &c. have nothing in common, except the spiral form, with the structures described in this article; they belong to the protoplasmic structures or *cell-contents*, as is also the case with the spirally-arranged green contents of SPIROGYRA; while this article refers exclusively to cellulose structures belonging to the *cell-wall*.

See also CELL, Vegetable; SECONDARY DEPOSITS; PITTED STRUCTURES; and TISSUES, Vegetable.

BIBL. General works on Vegetable Anatomy; Schleiden, *Ann. Nat. Hist.* vi. p. 35 (from the *Flora*, 1839); Griffith, *Ann. Nat. Hist.* x. p. 109; E. Quekett, *Trans. Mic. Soc.* i. p. 1; *Ann. Nat. Hist.* xv. p. 495; Mohl, *Verm. Schrift.* p. 285 (*Ann. des Sc. Nat.* 2 sér. xiv. p. 242); *Vegetable Cell*, London, 1852, p. 14; Agardh, *De Cell. Vegetab.* Lund, 1852; Crüger, *Botan. Zeit.* xii. pp. 57, 833 (1854), xiii. p. 601 (1855); Caspary, *Bot. Zeit.* xi. p. 801 (1853); Trécul, *Ann. des Sc. Nat.* 4 sér. ii. p. 273; Schacht, *Pflanzenzelle*, Berlin, 1852; *Bot. Zeit.* viii. p. 697 (1850); Unger, *Linnæa*, xv. p. 385 (1841); Herbert Spencer, *Linn. Trans.* xxv. p. 405.

SPIRILLI'NA, Ehr.—A doubtful genus of marine Infusoria, of the family Arcellina.

Char. Shell siliceous, porous, forming a flat spiral.

S. vivipara. Shell microscopic, hyaline, smooth, containing numerous embryo shells. Found in America.

BIBL. Ehrenberg, *Abhandl. d. Berl. Akad.* 1841, pp. 402, 422.

SPIRILLI'NA, Ehr., Rupt. Jones.—A genus of Rotaline Foraminfera, near *Pulvinulina*.

Char. Shell hyaline, consisting of a single elongated chamber, coiled into a flat close spiral; orifice simple, as wide as the tube.

Two recent British species, *S. perforata* (Pl. 47. fig. 5), and *margaritifera*; also some fossil (Jurassic and Tertiary).

BIBL. Williamson, *Rec. For.* 91; Carpenter, *Introd. For.* 180; Parker and Jones, *Ann. N. H.* 4. iv. 386; ix. 221.

SPIRIL'LUM, Ehr.—A genus of Oscillatoriaceæ.

Char. Consisting of a colourless, tortuous, or a cylindrical spiral filament.

These organisms, found in infusions and decomposing liquids, are very interesting objects on account of the remarkable character of their corkscrew-like movements. They multiply by transverse division, separating into two portions while in motion. They are jointed (or septate?); but the joints are not always easy of detection. They are insoluble in boiling potash. Their structure is best examined when they are preserved in a dry state. It is difficult to know where to place them in a system; but they are apparently nearest related to the Oscillatoriaceous Algæ. *Spirillum bryozoon* consists of the spermatozoids of Mosses.

1. *S. tenue.* Filament slightly tortuous, indistinctly jointed; spiral of three or four turns; movement active; length 1-1000″; diam. 1-12,000″.

2. *S. undula.* Filament very tortuous, distinctly jointed; spiral of one or one and a half turns; length 1-1500″; diam. 1-20,000″.

3. *S. volutans* (Pl. 3. fig. 23). Filaments very tortuous, distinctly jointed; spiral of three, four, or more turns; length 1-1400″; diam. 1-14,000″.

4. *S. plicatile* (*Spirochæta plicatilis*, Ehr.) (Pl. 3. fig. 22). Filament very long; coils very numerous; movement undulating; length 1-180″; diam. 1-12,000″.

BIBL. Ehr. *Infus.* p. 84; Dujard. *Infus.* p. 223; Rabenht. *Fl. Eur. Alg.* ii. p. 72.

SPIROCHÆ'TA, Ehr. (probably identical with SPIRILLUM).—*S. plicatilis* = *Spirillum plicatile.*

SPIROCHO'NA, Stein. — A genus of Infusoria, of the family Vorticellina.

S. gemmipara (Pl. 25. fig. 35) is found pon the branchial plates of *Gammarus Pulex*, where also its remarkable *Acineta*-form (Pl. 35. fig. 36) occurs.

S. Scheutenii is met with upon the feathery setæ arising from the terminal joints of the postabdominal legs of *Gammarus.*

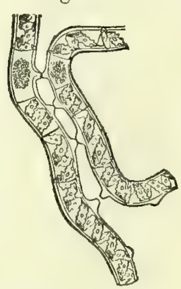
BIBL. Stein, *Die Infus.*; Pritch. *Infus.*; Clap. et Lachm. *Etudes*, p. 132.

SPIRODIS'CUS, Ehr.—Under the name *S. fulvus*, Ehrenberg places among the Infusoria, in the family Vibrionia, a brownish organism, consisting of a short discoidal or much-flattened helical spiral, 1-1200″ in diameter, and found in Siberia. It exhibited a slow movement. Ehrenberg's figure greatly resembles that in Pl. 32. fig. 34 (the upper two), without the cilia, and magnified 200 instead of 400 diameters.

BIBL. Ehr. *Infus.* p. 86.

SPIROGY'RA (*Zygnema*, Agardh in part) (fig. 668).—A genus of Zygnemaceæ (Confervoid Algæ), mostly very elegant, and all very interesting on account of their structure and modes of development. They are green filaments, floating unattached in standing fresh water. They consist of jointed tubes (that is, rows of cylindrical cells), sometimes of considerable size, in the interior of which the green colouring-matter is arranged in one or more spiral lines running round the walls, these spiral lines presenting bright points at intervals along their course (Pl. 5. figs. 17, 26, 27). The green lines consist of bands of protoplasm coloured green by chlorophyll. The bright points are in some stages composed of globules of similar substance; but generally they are occupied by starch-granules imbedded in the protoplasm; smaller starch-granules also occur at certain stages throughout the green band. A remarkable lenticular nucleus is also present, suspended in the centre of the cell by threads of protoplasm running out to the primordial utricle lying against the cell-wall. Sometimes this nucleus is placed with its faces towards the side wall (*S. nitida*, Pl. 5. fig. 26); sometimes it appears to be placed with its faces looking up and down, as it presents the appearance of a narrow ellipse when seen sideways (*S. pellucida*, Pl. 5. fig. 27). The laminated structure of the cell-walls is also curious, but will be better understood after a sketch of the mode of development.

Fig. 668.



Spirogyra communis. Fragments of two filaments conjugating. Magnified 200 diameters.

The attractive appearance of the *Spiro-*

gyræ and the easily observed phenomenon of conjugation have caused much attention to be paid to this genus; and many points of their history have been determined. The cells composing the filaments all multiply simultaneously when the plant is growing, each becoming twice its length and dividing into two. It has been certainly observed by A. Braun and Pringsheim that the division is preceded by a division of the nucleus. From this interstitial mode of growth it is evident that the walls of the cells of plants actively vegetating must soon become composed of a number of layers belonging to distinct generations of cells. Thus, supposing we have an original cell *a*, this encloses its progeny, two cells a^2 & *b*, and when these divide again and come to enclose respectively a^3 & *c* and b^2 & *d*, the parent cell *a*, stretched to *four* times its original length, still encloses the whole. The laminæ belonging to the respective generations do not become very intimately blended; for by maceration we may cause the outer membranes to soften and dissolve, and set free the younger cells intact. The older membranes seem to have become thinner by stretching, or by solution, midway between their septa, since on maceration we may often see them give way in the middle, and the young cells slip out from them, leaving them as short hyaline tubes with a diaphragm in the middle. The ends of the cells of some species generally present a curious appearance, which might be compared to the "punt" of a bottle, only it is a *circular fold* thrown in from the cross septum. It is attributed to the excessive growth of the membrane of the young cells, confined in space by the outer parent-membrane. The filaments of *Spirogyra* are consequently very instructive in reference to vegetative cell-formation. In some cases the half-dissolved parent-cell membranes form a delicate but well-defined gelatinous coat on the tube (Pl. 5. fig. 27 *s*).

The reproduction of this genus exhibits, besides the proper conjugation, other phenomena, the import of which is not yet fully determined. The conjugation itself has been observed by almost every microscopist. It consists essentially in the production of papillary elevations on the contiguous walls of the cells of two filaments lying side by side, the growth of these papillæ until they come into contact, and their coalescence so as to form a canal of communication between the two cells (fig. 668; Pl. 5. fig. 18). When this is accomplished, the contents of one of the cells (the contents of both having meanwhile lost their characteristic arrangement on the cell-walls) pass over through the cross tube into the other cell, when the contents of both become blended and form an elliptical free body (Pl. 5. fig. 18), which acquires cellulose integuments and becomes a *spore* or *zygospore*, lying free in the parent cell. This process is accompanied by the death of the parent filaments, conjugation often taking place in the majority of the cells: the spores are sometimes set free by decay of the parent cell-wall; but very often the latter remains undissolved until the germination of the spore (Pl. 5. fig. 19). A modification of this mode of conjugation occurs in some cases, apparently as an abnormal process; for it has been observed (Braun) taking place in those species which conjugate as above. It occurs in solitary filaments, in which two contiguous cells produce papillæ at the adjoining ends, growing towards each other and coalescing, the contents of one of the cells thus passing into the next cell of the same filament. A. Braun calls this "chain-like" conjugation, in contradistinction to the "ladder-like" conjugation above described. As the two forms occur associated, Kützing's genus *Rhynchonema* and others founded upon this are of doubtful value.

The ripe spore or zygospore presents the appearance of an elliptical body enclosed in three membranous coats, the outer of which is of delicate texture and separated by an interval from the next, which is brownish and of firm texture. The inmost coat, or true spore-membrane, is again delicate. The spores appear to rest through the winter after they are formed, and to germinate in spring, in which process the middle coat of the spore splits at one end, longitudinally, opening by two valves to allow the inner to grow forth, which bursts through the outermost sac, in the form of a tube (Pl. 5. fig. 19) which soon acquires the characteristic appearance of the parent plants. The contents of the spore are brown and homogeneous during the stage of rest (fig. 21); in germination they become green again, and arrange themselves in the spiral bands (fig. 22), which become more distinct as the cell elongates.

Certain other occurrences take place in the cell-contents of the *Spirogyræ*, the relation of which to the reproduction is not so clear as the above. In filaments in an unhealthy condition, about to decay, such as

are often seen when a collection of them is placed in a jar of water to keep for examination, it is not uncommon to see the green contents gradually lose their spiral arrangement and break up into a number of globular portions (Pl. 5. fig. 28); we have sometimes observed these rolling over slowly in the cell. In one case we have observed the contents converted into sixteen distinctly organized biciliated zoospores (Pl. 5. fig. 20), differing only from the ordinary zoospores of the Confervoids in the almost total absence of colour. They were somewhat crowded in the cell, and moved lazily about in it, the cilia vibrating. It is still more common to observe the contents of decayed filaments converted into encysted globules (Pl. 5. figs. 24, 25), which would appear to be a kind of resting-form of the zoospores. These globules, which have a tough spinulose coat, have been observed by Pringsheim as produced from the contents both of ordinary cells and (abnormally?) from the contents of a large spore (Pl. 5. fig. 23): the latter case might give colour to the idea that this was a sporange, had not its germination been observed. Pringsheim has further noticed that actively moving zoospores are produced from the small encysted bodies; perhaps these may fulfil an antheridial function. Carter has observed in the cells of *Spirogyra* the bodies constituting the genus *Pythium* of the German authors, and apparently connected with the zoospore-like bodies just described (see PYTHIUM).

The species of *Spirogyra* have been greatly multiplied by authors. The peculiar fold projecting from the septum appears to us to depend upon age and activity of growth; and the length of the joints depends greatly on the stage of growth, as they continually divide into two equal parts.

S. communis (fig. 668). Filaments 1-1440 to 1-1200″ in diam.; joints two or three times as long; turns of spiral four, broad; spores elliptical (Hass. pl. 28. figs. 5, 6).

S. quinina (Pl. 5. fig. 17). Filaments 1-600″ in diam.; joints once and a half or twice as long; turns of spiral broad and dense; spores elliptical. Varies to some extent in the length of the joints, which are sometimes twice to seven times as long.

S. nitida (Pl. 5. fig. 26). Filaments 1-360″ in diam.; joints twice or three times as long; spiral bands four, dense, closely veiled; spores elliptical.

BIBL. Hassall, *Brit. Freshw. Alg.* p. 135; Kützing, *Spec. Alg.* p. 437, *Tab. Phyc.* v.; Pringsh. *Flora*, xxxv. p. 465, 1852 (*Ann. Nat. Hist.* 2 ser. xi. p. 210); Al. Braun, *Verjüngung* (*Ray Soc. Vol.* 1853, passim); Vaucher, *Conferves*, p. 37; Agardh, *Ann. d. Sc. Nat.* 2 sér. vi. p. 197; Rabenh. *Fl. Eur. Alg.* iii. p. 232.

SPIROLI'NA, Lamk. (SPIRULINA, Ehr.). —Restricted. The long, narrow, crozier-like modifications of *Peneroplis* (*P.* (*Sp.*) *austriaca*, Pl. 18. fig. 12) come under this title. Fossil and recent.

BIBL. D'Orb. *For. Foss. Vien.* 137; Carpenter, *Phil. Tr.* 1859, 10; Parker, Jones and Brady, *Ann. Nat. Hist.* 3 ser. xv. 230.

SPIROLOCULI'NA, D'Orb. — A subgenus of *Miliola*, among the porcellaneous Foraminifera.

Char. Shell regular, equilateral, compressed, oblong, oval, or elongated; *chambers* concentric on two opposing faces, in the same plane, not embracing, all apparent and with simple cavities; *orifice* single, situated alternately at the two ends of the longitudinal axis, simple or with a tooth, frequently prolonged into a tube.

Sp. planulata (Pl. 18. fig. 7). Many species, recent and fossil.

BIBL. D'Orb. *Ann. d. Sc. Nat.* vii. 298; Williamson, *Rec. For.* 82; Carpenter, *Introd. For.* 77; Parker, Jones and Brady, *Ann. Nat. Hist.* 4 ser. viii. 248.

SPIROM'ONAS, Perty. — A doubtful genus of Monadina, probably synonymous with *Cyclidium* of Dujardin.

Char. Body leaf-like, compressed, rounded at both ends, and rolled spirally on itself longitudinally.

BIBL. Pritchard, *Infus.* p. 502.

SPIROPLEC'TA, Ehr. See TEXTULARIA.

SPIROR'BIS, Daudin, Lamk.—A genus of Annulata, of the order Setigera, and family Amphitritæ.

The elegant little milk-white flat spiral shells of *S. nautiloides* (*communis*) (Pl. 44. fig. 30) are frequently met with upon *Fucus serratus*, &c. The animal has six pinnate branchial filaments and a pedunculate operculum.

SPIROS'TOMUM, Ehr. — A genus of Infusoria, of the family Bursarina.

Char. Body ciliated all over, oblong or cylindrical and elongated or flat, without a neck; mouth spiral, with neither teeth nor a tremulous lamina; anus posterior.

S. ambiguum (Pl. 24. figs. 77, 78). Body cylindrical and elongated, colourless, obtuse in front, truncate behind, prolonged anteriorly beyond and above the mouth. Aquatic; length 1-12″.

Dujardin gives the characters :—Body cylindrical, greatly elongated, and very flexible, often twisted, covered with cilia arranged upon the oblique or spiral striæ of the surface; mouth situated laterally beyond the middle, at the end of a row of larger cilia ;—the genus consisting of *S. ambiguum*, E., and *S.* (*Uroleptus*, E.) *filum*, *S. virens* being placed as *Bursaria spirigera*.

Bibl. Ehr. *Infus.* p. 332; Dujard. *Infus.* p. 514; Pritchard, *Infus.* p. 622; Clap. et Lach. *Etudes*, p. 231.

SPIROTÆ'NIA, Bréb. — A genus of Desmidiaceæ.

Char. Cells single, elongated, cylindrical or fusiform, straight, entire, not constricted, ends rounded; endochrome spiral.

Division oblique. In one species the endochrome is spiral at first, subsequently becoming uniform.

1. *S. condensata* (Pl. 10. fig. 59). Endochrome forming a single broad band. Length 1-208″. Common.

2. *S. obscura.* Endochrome at first forming several spiral threads, afterwards uniform. Length 1-240″.

Bibl. Ralfs, *Brit. Desmid.* 178; Pritch. *Infus.* 751; Archer, *Qu. Mic. Jn.* 1867, p. 186.

SPIRULI'NA, Link.—A genus of Oscillatoriaceæ (Confervoid Algæ), consisting of minute spirally coiled filaments immersed in a gelatinous matrix, having an oscillating motion; forming extensive strata in lakes, brackish water, &c. The intimate structure and development of these curious organisms are not yet well understood; they are supposed to increase by the filaments breaking across; in some the filament appears continuous; in others it has striæ, like the *Oscillatoriæ* (appearing beaded when badly defined).

S. Jenneri (Pl. 3. fig. 16). Filaments with striæ, 1-6000″ in diameter, usually of eight or ten coils, forming a thin æruginous stratum.

S. oscillarioides (Pl. 3. fig. 15). Filaments not striated; coils 1-7200″ in diam.; lax. Among Oscillatorieæ in stagnant pools.

Bibl. Kützing, *Sp. Alg.* p. 236, *Tab. Phyc.* i. pl. 37; Hassall, *Brit. Fr. Alg.* p. 277, pl. 75; Harvey, *Brit. Mar. Alg.* p. 229, pl. 27; *Phyc. Brit.* pl. 105; Ralfs, *Ann. Nat. Hist.* xvi. 308, 2nd ser. viii. p. 205; Cohn, *Nova Acta*, xxiv.; Rabenht. *Fl. Eur. Alg.* ii. p. 90.

SPLACHNA'CEÆ.—A family of Funarioideæ (Acrocarpous operculated Mosses), of broad and densely tufted habit, mostly found upon dung, with a very much branched, loosely-leaved stem (fig. 669). Inflorescence hermaphrodite, diœcious, rarely monœcious. Antheridial flower a capituliform, terminal bud. Antheridia large, club-shaped, rather curved. Archegonia narrow, long-apiculate. Peristome, if present, of regularly lanceolate, neither obtuse nor trabeculate, twin, rufescent, rather fleshy teeth. Columella ordinarily projecting (fig. 670). Capsule on an apophysis (fig. 673), mostly furnished with stomates.

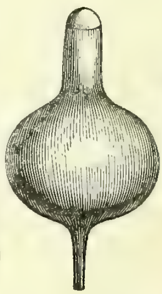
Fig. 669. Fig. 670.

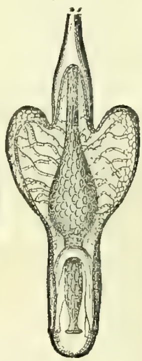
Splachnum vasculosum.

Fig. 669. Nat. size.

Fig. 670. Ripe capsule open, dried, and the apophysis shrivelled. Magnified 20 diameters.

Fig. 671. Fig. 672. Fig. 673.





Splachnum vasculosum.

Fig. 671. Calyptra. Magnified 20 diameters.

Fig. 672. Young capsule and apophysis. Magnified 20 diameters.

Fig. 673. Vertical section of an unopened capsule with its spongy apophysis. Magnified 20 diameters.

British Genera.

1. *Œdipodium.* Calyptra soft, longish-narrow, split almost to the summit, obtuse, somewhat lacerated at the base. Capsule subglobose, very loosely reticulated, soft, with a very long collum arising from a gradually thickened fruit-stalk, the mouth naked. Columella dilated at the apex. Inflorescence monœcious.

2. *Tetraplodon.* Calyptra smallish, hood-shaped, split to the middle, operculate, delicate. Capsule apophysate, oval-cylindrical. Apophysis obconical, obovate, or subovate. Columella scarcely dilated at the apex. Peristome of sixteen double teeth approximated in fours, lanceolate, formed of two rows of cells, connate in pairs at the base, reflexed when dry, erect, incurved when moist, much shorter than the capsule. Antheridial flower sessile in the axil of a leaf, or terminal in a little special branch, in a capituliform bud.

3. *Tayloria.* Calyptra inflatedly conical, erect, split at one side, constricted at the base, lacerated or erose all round the margin. Peristome arising below the orifice of the capsule, of sixteen or thirty-two teeth; teeth single, approximated in pairs or coherent, often very long; when moist incurved and involuted, when dry (in the ripe capsule) reflexed, appressed to the capsule or tortuously bent down; very hygroscopic. Inflorescence monœcious. Columella mostly free, exserted from the ripe capsule, flattish-apiculate.

4. *Dissodon.* Calyptra inflatedly conical, erect, slit at one side, constricted at the base and torn or erose. Peristome arising at the orifice of the capsule. Teeth thirty-two, connate, in eight bigeminate or sixteen geminate teeth, lanceolate, smooth, transversely articulate, connivent into a depressed cone when moist, subincurved when dry. Inflorescence perfect or monœcious. Columella included or exserted, flattish.

5. *Splachnum.* Calyptra conical, rather small, entire or slit here and there at the base. Peristome of sixteen teeth, composed of a double row of cells, lanceolate, largish, yellowish, approximated in pairs and to some extent conglutinated, when dry reflexed and appressed to the capsule, when moist erect and incurved at the apex. Inflorescence diœcious, rarely monœcious. Columella ordinarily emerging, capitate.

SPLACHNUM, Linn. — A genus of Splachnaceæ (see above). *S. ampullaceum* Linn., not uncommon on the dung of animals on bogs, is a very handsome moss, with purple or red capsules. *S. vasculosum* (figs. 669–673) is less common, occurring only in high mountain districts.

SPLEEN.—This organ appears to occur exclusively in the Vertebrata, but is not found in the Leptocardia and Myxinoids. The spleen is covered externally by the

Fig. 674.

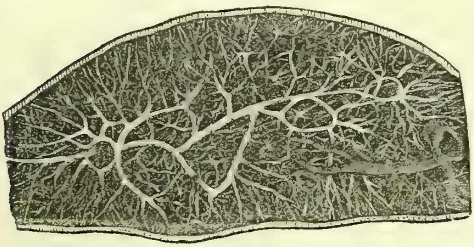


Fig. 675.

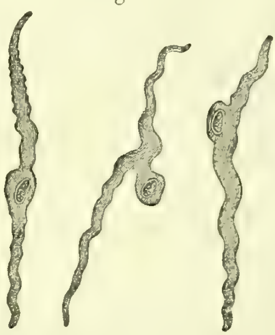


Fig. 676.

Fig. 674. Natural size. Portion from the middle of the spleen of an ox, washed; showing the bands and their arrangement.

Fig. 675. Peculiar fibres from the pulp of the human spleen, belonging to the microscopic trabeculæ. Magnified 350 diameters.

Fig. 676. One of the same enclosed in a cell. Magnified 350 diameters.

peritoneum, except at the hilus, where the vessels are connected with it.

Beneath the peritoneal tunic is a thin, semitransparent, firm, fibrous coat, which at the hilus accompanies the vessels, and forms sheaths around them.

The spleen is traversed by fibrous processes, bands or trabeculæ (fig. 674), which

arise from the inner surface of the fibrous coat and from the outer surface of the vascular sheaths, and, being connected with each other, form a number of irregular meshes or areolæ, in which are situated the splenic corpuscles and the spleen-pulp. In reptiles they form stellate expansions, their connective tissue becoming infiltrated with lymph-corpuscles; and the connective tissue in this modified form occupies all the interspaces of the proper parenchyma of the organ.

The fibrous coat and the trabeculæ consist of ordinary areolar tissue, with mostly parallel fibres, traversed by networks of fine elastic fibres, which become continuous with the coats of the veins. In certain animals, as the dog, cat, pig, &c., the fibrous coats and trabeculæ contain also unstriped muscular fibres. These do not occur in man, unless they are represented in the microscopic trabeculæ by peculiar wavy fibres, about 1-500″ in length, with lateral or stalked nuclei (fig. 675). Some of these are found enclosed in cells (fig. 676), from which they become liberated by the action of water. The arteries, first of all, in connexion with the trabecular sheath are generally accompanied by a connective sheath rich in cells, until they become capillaries; and this cell-growth becomes developed into the Malpighian corpuscles.

The splenic or Malpighian corpuscles (fig. 677) are white rounded bodies, imbedded in the spleen-pulp, and attached to the smallest arteries. They vary in size from 1-120 to 1-36″, and cannot always be detected. They are either placed upon the sides of the arterial branch, or situated in the angles of their bifurcation.

The splenic corpuscles consist of an enveloping membrane (fig. 678 *a*) composed of areolar tissue with fine reticular elastic fibres, and derived from the arterial sheath. They are traversed by capillaries and filled

Fig. 677.

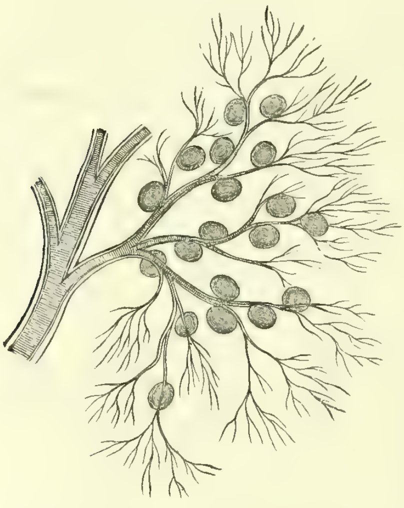


Fig. 678.

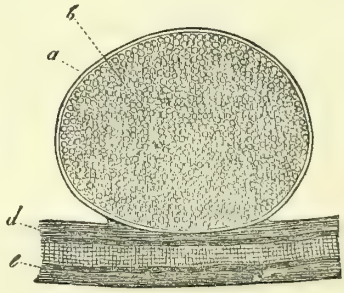


Fig. 677. Portion of a small artery from the spleen of a dog, with one of the branches covered with Malpighian bodies. Magnified 10 diameters.

Fig. 678. Malpighian corpuscle from the spleen of an ox. *a*, wall of the corpuscle; *b*, contents *e*, wall of the artery upon which it is situated; *d*, its sheath. Magnified 150 diameters.

with a tenacious grey parenchyma. The parenchyma consists of cells 1-3000″ in diameter, containing one or two nuclei, and free nuclei (fig. 104, p. 132). There is also an intermediate substance, the periplast of Huxley, a pale granular fibrillar substance which encloses the cells. Sometimes the cells contain globules of fat or blood-corpuscles; and occasionally free blood-corpuscles are met with.

The splenic pulp forms a soft reddish mass, and consists of three elements—microscopic trabeculæ, fibres, or bands, parenchyma-cells, and the smaller blood-vessels—or of cells and an intercellular substance. The trabeculæ agree in structure with the larger

ones. The fibres or bands are the terminations of the sheaths of the vessels; they are indistinctly fibrous, and free from elastic tissue. The parenchyma-cells resemble those in the splenic corpuscles. Blood-corpuscles are found enclosed in cells, from one to twenty in each, or surrounded by a transparent substance, their contents exhibiting various changes in colour and consistence. The arteries terminate in elegant tufts or penicilli, becoming continuous with a meshwork of capillaries.

The blood-corpuscles from the blood of the splenic vein frequently contain crystals of hæmatoidine.

In the examination of the spleen, the trabeculæ are best seen after washing away the pulp with water, the splenic corpuscles by tearing the spleen or boiling it, either in the pig or ox. The cells containing blood-corpuscles must be searched for in the pulp unacted upon by water. The muscular fibres are most evident in the smaller trabeculæ, especially after treatment with dilute nitric acid (one part to five parts of water).

Bibl. Kölliker, *Mikrosk. Anat.* ii. 253, and *Todd's Cycl. Anat. &c.*, art. *Spleen*; Gray, *A. Cooper's Prize Essay*; Saunders, *Goodsir's Annals of Anat. &c.* 1851, i.; Crisp, *On the Spleen*; Huxley, *Qu. Mic. Jn.* ii. 1854; Frey, *Das Mikros.*; W. Müller, *in Stricker's Hum. & Comp. Hist.* and the *Bibl.* therein.

SPOLVERI'NA, Mass.—A genus of Micro-lichens, parasitic on the thallus and prothallus of various crustaceous lichens.

Char. Spores 1–2, large, globose-ovoid, simple, colourless, or yellowish.

Bibl. Lindsay, *Qu. Mic. Jn.* 1869, p. 344.

SPONDYLOM'ORUM, Perty.—A genus of Hydromorina.

Char. Body with a dorsal ocellus, with no tail, self-division imperfect, developing a compound body like a cluster of berries.

Bibl. Pritchard, *Infusoria*, p. 505.

SPON'GIDA or PORIF'ERA.—The sponges belong to the animal kingdom, and are usually associated with the Protozoa. Haeckel regards them as an approach to the Cœlenterata; and Prof. Clark believes them to be aggregations of cilio-flagellate Infusoria. The essential histological element of all Spongida is a sarcode which is partly differentiated into cells which resemble ciliated monads. Some of these have only one flagellum, which is surrounded by a kind of collar where it is attached to the body of the cell. The rest of the sponge-sarcode consists of a structureless protoplasm. The non-essential element is a framework or fibrous skeleton which gives definite shapes to the whole, and which is surrounded by the sarcode, and produced by the assimilative powers of the cells and protoplasm. The skeleton may be horny, calcareous, or siliceous; and hence the group has been subdivided into:—1. The *Keratosa*, in which horny fibres exist forming an interlacement, with meshes, canals, and also large oscula and small external pores, such as the skeleton of the common sponge of commerce. The horny fibres are cylindrical or united without any definite order.

The fibres of the Keratosa have been described as solid and as tubular. Those of the common sponges appear under the microscope to be solid; but when treated with sulphuric acid, it is easily seen that they consist of two parts, an outer tubular portion, which is contracted in length by the acid, and an inner cylindrical thread, which is not so contracted, but usually becomes elegantly wavy or spiral from flexion, frequently also partly protruding from the cavity of the outer portion in broken fibres.

The horny fibres are strengthened in some species with calcareous or with siliceous spicula.

2. The *Calcarea* or *Calcispongia*. In these the skeleton is composed of aggregations of calcareous spicula. It frequently has only one set of pores opening into meshes and canals, and these into one osculum; in many species, however, there is the same abundance of pores and oscula as exists in the Keratosa. But in the first instance there is, as it were, one individual sponge, and in the last numerous aggregated individuals. It is the solitary individual calcareous sponge which Haeckel has placed *en rapport* with the Actinida.

3. The *Silicea*. The siliceous Spongida have a skeleton consisting of spicules of silica differently arranged according to the genus and species, or of solid siliceous fibres, or of both.

This division has been made much more important since deep-sea dredging has been properly conducted; and a new order, the Hexactinellidæ, has been formed to include all siliceous sponges with a siliceo-fibrous or siliceo-spicular skeleton, the spicules of the sexradiate-stellate type being invariably present. There are two suborders of these beautiful forms. In one, the Corallio-spongiæ (Gray), the skeleton is conti-

nuously reticulate, as in *Euplectella* and *Aphrocallistes*; and in the other, the Callicispongiæ (Kent), the skeleton consists of disconnected, interlacing, or of isolated spicules, as in *Hyalonema*, *Sympagella*, or *Dorvillia*.

The spicula, whether calcareous or siliceous, are of various forms (Pl. 36, the lettered figures), and either scattered through the sarcode or arranged in bundles forming spurious fibres, sometimes projecting more or less from the surface (Pl. 36. fig. 8). In some sponges they are absent, and in one genus they are replaced by gravel. There is some obscurity about the gravel, however; for its particles are described as being uncrystalline, and as neither siliceous nor calcareous!

Whether the skeleton is continuous or simply spiculate, or whether it is bearded with long threads or has long rope-like roots, still the soft parts are in close apposition with the hard. The relation of the protoplasm and cell-structures of the sarcode to the spicule is that of simple investment.

The common *Spongilla*, a freshwater species, has been considered the best type for the study of the minute anatomy of the group so far as the soft parts are concerned. The superficies is composed of a thin layer of sarcode with small pore-like openings in it, which lead to a cavity between it and the bulk of the sponge. The sarcode is composed of nucleated cells placed side by side. They can produce pseudopodia and seize and include nutrient particles like *Amœba*. This power of pseudopodial elongation of the cell-substance exists after separation from the other cells, and is noticed also in the cells which bound the lower part of the above-mentioned cavity. Many if not all of the cells are ciliated; and the movement of the cilia to a certain extent produces currents in the water, by which it is forced down the pores into the cavity. The cavity is bounded below by the main body of the sponge, which is noticed to have on it openings reaching downwards into canals or spaces; and these converge to the larger superficial openings of the sponge called oscula. The sarcode lining these has in many positions, which are called ciliated or spheroidal chambers, a very definite structure: the cells composing it greatly resemble Cilio-flagellate Infusoria; and each cell is attached to others, all having nuclei, a frontal collared prolongation, and a long cilium. These cavities are in communication with the canals, and determine currents from without inwards. Clark considers that the structureless protoplasm which lines chambers in the American *Spongilla*, corresponding to the canals in the European form, has a sufficient power of contraction to produce an expulsion and subsequent inrush of water. The water-currents pass into the sponge by the pores, and circulate, carrying animalcules and minute organisms along the cavities, spheroidal chambers, and canals to make their exit by the large external openings, the oscula.

Sponges are mostly marine, rarely freshwater. Usually they possess lively colours, which appear in some instances to arise from the presence of granules of colouring-matter, probably chlorophyll, in others from iridescence. They usually grow in groups upon rocks, shells, polypes, sea-weeds, &c.

Two reproductive processes are known to occur in the Spongida, one being asexual and the other truly sexual. In the common *Spongilla*, towards the autumn, the deeper layer of the sponge becomes full of exceedingly small bodies called "seeds" or "gemmules," which are spheroidal and have an opening at one point. Every one of these bodies, in the walls of which are arranged a number of remarkably shaped spicula, each resembling two toothed wheels joined by an axle, is in point of fact a mass of sponge particles which has set itself apart (gone into winter quarters so to speak), and, becoming quite quiescent, encysts itself and remains still. The whole *Spongilla* dies down, and the seeds, enclosed in their case, remain uninjured through the winter. When the spring arrives, the encysted masses within the "seed," stimulated by the altered temperature of the water, creep out of their vents and straightway grow into *Spongilla* (Huxley). Probably there is another form of asexual increase, in which ciliated masses containing minute germs pass out of the sponge, swim freely with the aid of their cilia, and give forth their swarm-spores which are ciliated.

The sexual method takes place in summer time. Huxley has described spermatozoa in *Tethya*, Lieberkühn in *Spongilla*, and Haeckel in various calcareous Spongida. They are developed by particular sponge-cells becoming granular in their contents, and the granules develop into spermatozoa; or they occur in modifications of flagellate

cells. The ova are formed by cells separating themselves from the sarcode, and becoming nucleated and nucleolated. The granule-cells burst, and the spermatozoa are set free, and, coming into contact with the ova-cells, impregnate them and determine the development of ciliated germs. These escape from the ova-cell, swim freely, and finally attach themselves and grow into *Spongillæ*.

Thread-cells have been found in the genus *Reniera*; and Eimer states that he has even distinguished in some siliceous forms something like connective tissue and fusiform muscular fibres.

BIBL. Johnston, *Brit. Sponges*; Grant, *Edinb. New Phil. Journ.* 1827; Hogg, *Ann. Nat. Hist.* 1841. viii. 3, and 1851, vii. 190; Bowerbank, *Trans. Micr. Soc.* 1840, i., *Monog. Brit. Spong. Roy. Soc.* 1866, *Proc. Zool. Soc.* 1870; Carter, *Ann. Nat. Hist.* 1848, i. 303, 1849, iv. 81, 1854, xiv. 334, and 1856, xviii. 1857, xx. 21; Dobie, *Ann. Nat. Hist.* 1852, x. 317; Huxley, *ibid.* 1851, vii. 370, and *Elem. Comp. Anat.*; James-Clark, *American Jn. of Sci. & Arts*, Dec. 1871, *Qu. Mic. Jn.* 1868, p. 50, *Ann. Nat. Hist.* xix. 1867, p. 13, 1868, i. pp. 133, 188, and 1872, ix. p. 71, *Mo. Mic. Jn.* 1872, p. 104, *Qu. Mic. Jn.* 1872, p. 409; Haeckel, *Ann. Nat. Hist.* 1870, v. p. 1 & 107, *Jenais. Zeit.* 1869, iv. B. 1871; Carter, *Ann. Nat. Hist.* 1871, viii. p. 1, 1872, x. p. 306; Kent, *Mo. Mic. Jn.* iv. p. 241, *Qu. Mic. Jn.* 1871, p. 90; Gray, *Ann. Nat. Hist.* 1868, i. 161, *Proc. Roy. Soc.* 1867; Lieberkühn, *Müller's Archiv*, 1856, *Ann. Nat. Hist.* 1868, ii. p. 236; Thomson, *Ann. Nat. Hist.* 1868, i. p. 114, *Phil. Trans.* 1869, *Mo. Mic. Jn.* ii. p. 107, *Deep-sea Dredging*; Ellers, *Sieb. und Köll. Zeit.* 1871, xxii. p. 540, *Qu. Mic. Jn.* 1870, x. p. 1, tr. Wright; Eimer, *Schultze's Archiv*, pt. 2, 1872; Walker, *Jn. Quekett Soc.* No. 19, 1872; Claus, *Ueber Euplectella*, O. Marburg, 1868; Leidy, *Amer. Nat.* March 1870; Bocage, *Jn. des Sci. Nat. &c.*, Lisbon, 1869; Pourtales, *Bull. Mus. Comp. Zool. Harvard Coll. Mass.* 1867, 1868; L. Agassiz, *Bull. &c. Harvard Coll. Mass.* 1869; Miklucho-Maklay, *Mém. de l'Acad. Imp. Pétersbourg*, 1870; Oscar Schmidt, *Grundz. einer Spongienfauna d. Atlan. Geb.* Leipzig, 1870; *Spong. d. Küste v. Algier*, Leipzig, *Spong. d. Adriat. Meer.* Leipzig.

SPONGIL'LA, Lam.—A genus of fresh-water sponges.

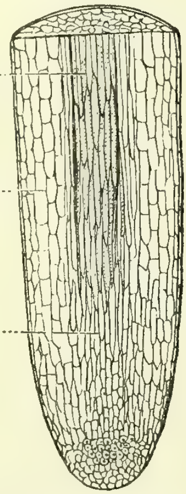
Two British species, *S. fluviatilis* and *S. lacustris*.

Found attached to stones, old woodwork, &c. in still or slowly running waters; green or grey.

See SPONGIDA.

SPONGIOLES.—Many works on vegetable physiology still retain the old error that the extremities of roots are devoid of epidermis, and that the tissue then presents an open spongy character, whence the name of *spongioles* applied to the absorbing apices of roots. So far is this from being a correct account of the conditions, that, in reality,

Fig. 679.



Longitudinal section of the rootlet of an Orchis.
C, *C*, Cellular tissue (cambium) in which development is still going on. *FP*, Fibro-vascular bundles gradually becoming organized from above downwards.
Magnified 500 diameters.

not only is the surface completely invested with a continuous epidermis, but the growing point and principal absorbing surface is found a little above the absolute extremity, which is pushed forward by interstitial growth.

See ROOTS.

SPORAN'GIUM and SPOR'OCARP.—The term sporangium is applied to the structure immediately enclosing the spores of the Cryptogamia. The different forms and conditions are described under the classes of Flowerless plants. Abortive sporangia in Ferns, sometimes borne on the pedicel of the true sporangia, are called sporangiastra. Sporocarp or spore-fruit is the name given to the capsules or similar organs

which contain the sporanges of the Marsileaceæ (see PILULARIA).

SPORENDONE'MA, Desm. — A supposed genus of Sepedoniei (Hyphomycetous Fungi). It is a very common occurrence in autumn to find the house-fly, dead, adhering to walls, window-panes, &c., firmly fixed by its proboscis, and with its legs spread out, thus differing from dead flies in general, which have the legs contracted. In about twenty-four hours after death, a kind of fleshy substance, of a white colour, is found in the form of a ring projecting out between each of the rings of the abdomen; and in a day or two after, the whole will be found dried, and the surface of the wall or glass lightly covered in a semicircle, at about 1-2 to 1″ from the fly's abdomen, with a cloud of whitish powder. The whitish fleshy substance is found on examination to consist of a vast number of short erect filaments growing out from the interior of the fly's body, between the rings; these filaments contain large oil-globules, often arranged in a row; and their having been mistaken for spores gave origin to the name *Sporendonema* applied to this fungus. Cohn has lately described its growth somewhat minutely, and changed the generic name to *Empusa*, or rather *Empusina*, the first of these names being already occupied. He correctly states that the vertical filaments terminate in the abdomen in a continuous, often branched tube, and consist therefore of a single tubular cell. The upper free end, however, becomes cut off by a septum, and the terminal cell acquires a campanulate form and a darkish colour; when ripe, it is thrown off with elasticity; and a number of these form the white cloud above mentioned. Cohn endeavoured in vain to make them germinate; and nothing like them was found in the cavity of the abdomen of numerous flies in which the filaments were traced in their earlier stages. From our own observations, we rather incline to regard them as *peridioles* or spore-cases, comparable perhaps to that of *Pilobolus*; or they may be stylospores, like some of those of the Uredinei, which after a stage of rest produce an intermediate mycelial structure, and then give birth to the ripe spores.

The most remarkable point about this fly-fungus (to which, however, Cohn does not allude) is the circumstance that, when the body of the fly with the rings of fungi freshly developed is placed in water, ACHLYA *prolifera* is almost always, if not always, produced, and apparently from the filaments which in the air produce the bell-shaped deciduous body above described. We find the *Achlya* with its ciliated zoospores, and later with its globular sporanges filled with spores, apparently representing an aquatic form of the *Sporendonema* or *Empusina*.

Cienkowski has recently confirmed the view that *Achlya* is an aquatic form of the present plant; but A. Braun denies this; he states that he has found a second species of *Empusina* on the common gnat (*Culex pipiens*).

Sporendonema Casei, Desm., is referable to TORULA.

BIBL. Berk. *Brit. Flora*, ii. pt. 2. p. 350; Fries, *Syst. Myc.* iii. p. 435, *Summa Veget.* p. 494; Varley, *Trans. Mic. Soc. Lond.* iii.; Cohn, *Nova Acta*, xxv. p. 299; Berk. and Broome, *Ann. Nat. Hist.* 2nd ser. v. p. 460; Cienkowski, *Bot. Zeit.* xiii. p. 801; Al. Braun, *Alg. Unicell.* p. 105.

SPORES, SPORULES, SPORIDIA, SPORIDIOLA, MICROSPORES, MACROSPORES, &c.— A number of nearly connected terms which are applied to the various organs which either really or apparently represent, in the Flowerless Plants, the *seeds* of the Flowering classes. The names have been mostly applied with a view of marking slight distinctions between organs supposed to be homologous. Of those placed at the head of this article, the first only should be retained, the second being merely a useless diminutive of it, and the third and fourth being superseded by the more definite nomenclature now applied to the reproductive bodies of the Cryptogamia.

It may be desirable perhaps here, if merely for the sake of explaining the exact meaning of words constantly used in this work, to pass in review the various structures comprehended under the general name of Spore.

The definition of the word spore itself, as commonly used, may be stated thus:—a reproductive body, thrown off by a Flowerless plant to reproduce its kind, and containing no embryo at the moment when cast off by the parent. It is evident from this how lax is its application.

The highest of the Flowerless plants, the Marsileaceæ and the Lycopodiaceæ, produce two kinds of spore—one destined to produce spermatozoids, the other archegonia and ultimately embryos growing up into new plants. These are now sometimes distinguished as *pollen-spores* and *ovule-spores* or *oospores*; the latter are large sacs with com-

plicated outer membranes, the former simple cells with a double coat, like pollen-grains (see PILULARIA, ISOËTES, and LYCOPODIACEÆ).

The Ferns and the Equisetaceæ produce only one kind of spore, a simple cell with a double coat, the outer of which is generally elegantly marked in the former (figs. 232–235, p. 308), and is split up into elastic filaments or elaters in the latter (fig. 205, p. 288). In germinating, this spore produces a kind of thallus, the prothallium (figs. 236–239, p. 309), on which antheridia and archegonia ultimately appear, and an embryo is formed, fertilized, and developed (see FERNS and EQUISETACEÆ).

In the above cases the spores are always formed in sporanges of various kinds, developed directly from the axis or the leaves by a process of vegetative growth.

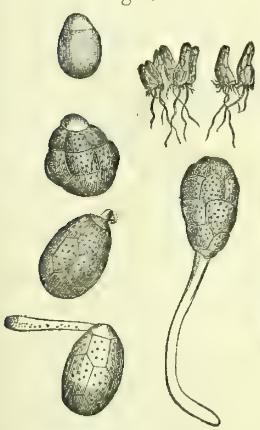
In the Mosses and Liverworts (p. 482) the spores are mostly of one kind (an obscurity exists as to the nature of the difference between the two kinds in SPHAGNACEÆ), consisting of a cell with a single or (generally) double coat, like a pollen-grain. The spores unlike those above-mentioned are formed in sporanges which are the product of fertilized archegonia, and more resemble the *fruits* of Flowering plants. The spores of Mosses germinate by emitting the inner coat as a Confervoid filament (fig. 680), which usually branches and gives origin to numerous stem-buds. The spores of the Liverworts exhibit many modifications in the first stages of germination, as illustrated by the accompanying figures (figs. 681–683); the Marchantieæ and other frondose kinds grow at once into thalloid fronds (see MOSSES and HEPATICÆ).

Fig. 680.

Spores of a moss germinating. Magn. 100 diams.

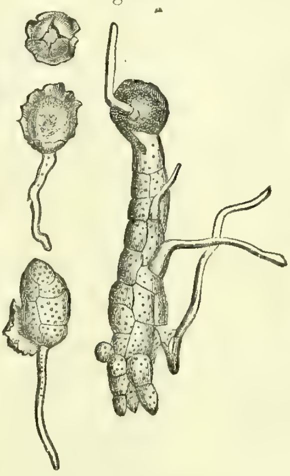
The systematic position of the Characeæ is perhaps still an open question; but there can be little doubt of the analogies between these reproductive bodies and those of the other Cryptogamia. There is no sporange here, nor apparently any archegonia. The *globule* (figs. 121 & 122, p. 156) produces antheridia giving birth to spermatozoids. The *nucule* (fig. 120, p. 155) appears to be a spore (see CHARACEÆ).

Fig. 681.



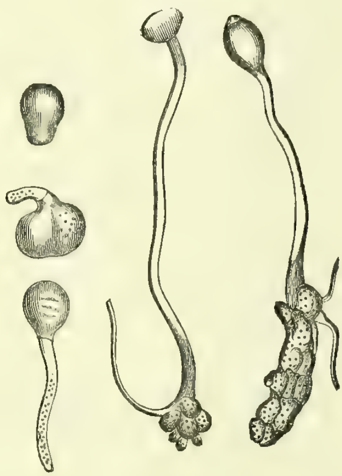
Pellia epiphylla.

Fig. 682.



Preissia commutata.

Fig. 683.



Blasia pusilla.

Spores of Hepaticæ germinating. Magnified 200 diameters.

In the Lichens, only one kind of organ has been termed a *spore*, namely the reproductive cells formed in the thecæ (Pl. 29. figs. 6 & 12), which are known to reproduce the plant when thrown off by the parent. Two other kinds of body connected with the reproduction occur: these, the *gonidia* (Pl. 26. figs. 2, 3) and the *spermatia* (see LICHENS), have fortunately obtained and

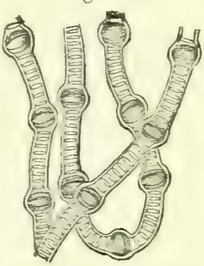
preserved distinctive appellations. The spores are simple cells or septate tubes, with a double membrane.

In the Algæ much confusion still exists, not only between different kinds of spore, but even between spores and sporanges; and this is not easily cleared away, since in certain cases the organs appear really capable of serving as one or the other, according to circumstances; the true spores are always simple cells with a double or triple coat.

In the Florideæ, the characters of the structures seem pretty clear: we find spores (p. 314), TETRASPORES (figs. 248–250, p. 314), (which appear to represent the gonidia of the Lichens), and spermatozoids (see FLORIDEÆ). Among the olive-coloured sea-weeds (Fucoids), the FUCACEÆ and DICTYOTACEÆ produce spores and spermatozoids; but in the majority of the families, only a totally different mode of reproduction is known. The plants produce ovate sacs (commonly called spores) and chambered filaments; from both are discharged actively moving ciliated cells, corresponding exactly to the ZOOSPORES of the Confervoids. Thuret now regards the *oosporanges* and *trichosporanges* (fig. 458, p. 492), as he called these sacs and filaments respectively, as merely different forms of one kind of structure. But it seems possible that true *spores* may be discovered, even indeed that the oosporanges may be parent cells sometimes of zoospores and sometimes of spores.

In the Confervoids we find true spores in very many cases, produced generally after some process of fertilization or of CONJUGATION, in special cells (fig. 668, and Pl. 5. figs. 16 & 18; Pl. 6. figs. 1–5). But the "spores" thus produced, while they sometimes germinate into new filaments, also sometimes produce numerous bodies of different kinds, connected in some way with reproduction; this is the case in SPIROGYRA (Pl. 5. fig. 23), perhaps also in CLOSTERIUM and other instances. Besides the *spores* proper,

Fig. 684.



Nodularia spumigera.

Filaments with sporongial cells containing quaternate spores.

Magn. 200 diams.

we have also in this family ZOOSPORES—the actively moving ciliated bodies which are regarded as *gonidia* and are further divided into *macrogonidia* and *microgonidia* (see HYDRODICTYON), the latter of which may perhaps have the function of spermatozoids (see SPHÆROPLEA and VAUCHERIA).

Resting-spores. See SPHÆROPLEA.

In the Fungi the greatest confusion exists in the nomenclature. The Agarics and their congeners produce free naked cells at the tips of short filaments, whence they ultimately fall off, to reproduce the plant; these are called *spores* or *sporules*, or distinctively BASIDIOSPORES (figs. 53–55, p. 88). There is no essential difference between them and the spores produced by the Hyphomycetes, either singly or in rows or capitula (BOTRYTIS, figs. 77, 78, p. 111; figs. 685, 686;

Fig. 685. Fig. 686. Fig. 687.

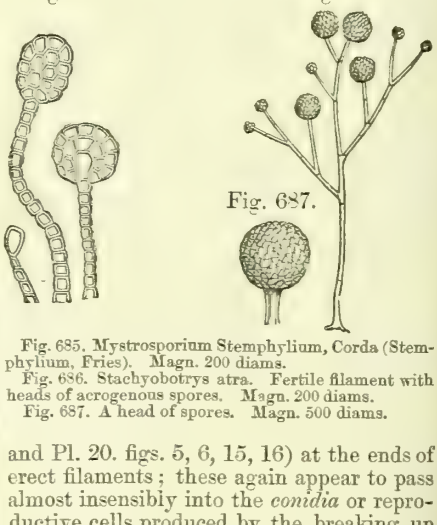


Fig. 685. Mystrosporium Stemphylium, Corda (Stemphylium, Fries). Magn. 200 diams.
Fig. 686. Stachyobotrys atra. Fertile filament with heads of acrogenous spores. Magn. 200 diams.
Fig. 687. A head of spores. Magn. 500 diams.

and Pl. 20. figs. 5, 6, 15, 16) at the ends of erect filaments; these again appear to pass almost insensibly into the *conidia* or reproductive cells produced by the breaking up of the mycelium, either wholly or in part, into free cells capable of continuing the growth (TORULA, Pl. 20. fig. 7, and OIDIUM, Pl. 20. fig. 8): on the other hand, the *spermatia* (Pl. 20. figs. 2, 3, 4), such as occur in some of the Coniomycetous forms of the Pyrenomycetous and Discomycetous Fungi, are closely related, as far as structure goes, to the conidia of *Torula* &c. and the spores of the Hyphomycetes; while the *stylospores* of the UREDINEI and TREMELLINI produce bodies resembling them, and still more like the basidiospores of the Agaricini. The stylospores, another free

form of spore, may be regarded probably as compound organs, formed of a row of cells contained in a persistent parent cell: it is surmised that they are merely metamorphosed asci (see SPHÆRIA and STILBOSPORA, Pl. 20. figs. 25–28); yet their mode of occurrence would lead to the idea that they are a distinct kind of organ. Lastly, we have the *ascospores* or *thecaspores* (fig. 42, p. 75), closely resembling those of the Lichens, consisting of free cells with a double coat, developed free in the cavity of a parent cell or sac. In the *British Flora* the terms *sporule* and *sporidium* are used synonymously in the sense of *spore*, and are applied to basidiospores, ascospores, stylospores, and to the bodies (found in *Cytispora, Tubercularia*, &c.) called by Tulasne spermatia. The term *sporidiola* is applied apparently to nuclei or granular masses occurring in the cavities of spores, or to the separate portions of contents of imperfectly septate stylospores.

Auxospores, according to Pfitzer, are probably peculiar to Bacillariaceæ. By a continuous process of fission into two, the size of the single cells diminishes till at length it reaches its minimum, whereupon there interposes a formation of spores, which checks the regular process of division, and produces cells possessing the maximum size of the species, and in all respects like the mother cell (*Qu. Mic. Jn.* 1873, p. 145).

With regard to the homologies of the above structures, the *spermatia* are supposed

Fig. 688.

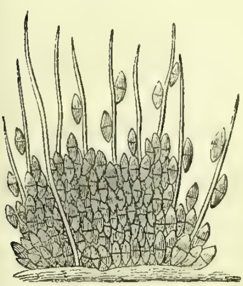


Fig. 689.

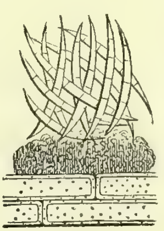


Fig. 688. Leptotrichum glaucum. Free spores among the filaments of the matrix. Magn. 200 diams.

Fig. 689. Fusarium herbarum. Free spores resting on the matrix. Magn. 200 diameters.

to represent spermatozoids; the *conidia* are regarded as corresponding to gonidia of Lichens; the stylospores are also connected with these through the medium of the tetraspores of the Florideæ.

In conclusion, a reference may be made to descriptions and figures like those given (figs. 688, 689) of *free* spores resting on the matrix and among the filaments. Such characters are totally out of date in the present state of science, and simply serve as indices of points requiring further investigation.

BIBL. See under the heads of the classes of Cryptogamic Plants.

SPORIDES'MIUM.—A genus of Torulacei (Coniomycetous Fungi), growing upon bark, wood, &c. See TORULACEI.

Fig. 690.

Sporidesmium paradoxum. Spores sessile on the matrix. Magn. 200 diams.

SPOROCHIS'MA, Berk. and Br.—A genus of Torulacei (Coniomycetous Fungi), containing one species, *S. mirabile*, forming a black velvety stratum on rotten beech wood. See TORULACEI.

SPOROCHNA'CEÆ.—A family of Fucoideæ. Olive-coloured, inarticulate seaweeds, whose unilocular and septate sporanges are attached to external jointed filaments, which are either free or compacted together into knob-like or warty masses.

Synopsis of British Genera.

* *Sporanges attached to pencilled filaments issuing from the branches* (Arthrocladieæ).

1. *Desmarestia. Frond* solid or flat, dichotomously branched.

2. *Arthrocladia. Frond* traversed by a jointed tube, filiform, nodose.

3. *Stilophora.* Frond filiform, tubular or solid, branched; sporanges arising from necklace-shaped filaments collected in wart-like groups upon the frond.

** *Sporanges produced in knob-like receptacles composed of whorled filaments compacted together* (Sporochneæ).

4. *Sporochnus. Receptacles* lateral, on short peduncles.

5. *Carpomitra. Receptacles* terminal, at the tips of the branches.

SPOROCH'NUS, Ag.—A genus of Sporochnaceæ (Fucoid Algæ), containing one British species, *S. pedunculatus*, having a filiform, solid, cellular main axis (containing a central cord of dense tissue) bearing

long slender branches arranged in a somewhat pinnate manner and clothed at intervals with elliptical fertile ramules, consisting of an axis densely covered with whorled horizontal branching filaments bearing ovoid *sporanges*, and terminating in a deciduous pencil of byssoid filaments. Main stem 6 to 8″ long, olive-brown, changing to yellow-green on exposure.

Bibl. Harvey, *Brit. Mar. Alg.* p. 25, pl. 5 A; Greville, *Alg. Brit.* pl. 6; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 238.

SPOROC'YBE, Fries.—A genus of Dematiei (Hyphomycetous Fungi), growing on dead sticks, decaying stems, &c., forming usually a blackish stratum. Several British species are recorded. They have a rigid, septate, simple or branched peduncle, ending with a capitate head clothed with spores

Fig. 691.

Fig. 692.

Sporocybe bulbosa.

Fig. 691. Stratum upon a stick. Nat. size.
Fig. 692. Two fertile peduncles, crowned with heads of spores. Magnified 100 diameters.

(figs. 691, 692). This genus is synonymous with *Periconia*, Corda. *Periconia*, Tode, is an obscure form, not well understood.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 333; *Ann. Nat. Hist.* vi. p. 433, pl. 13; Fries, *Summa Veget.* p. 467: *Syst. Mycol.* iii. p. 340.

SPOROT'RICHUM, Link.—A genus of Mucedines (Hyphomycetous Fungi), growing on decaying vegetable substances, dung, &c. The forms referable to this genus, according to the character, include a very heterogeneous assemblage; indeed the character, which omits the nature of the original attachment of the spores, is worth nothing. Fries has separated a genus Trichosporium, including a number of species with distinctly acrogenous spores; this includes *S. nigrum* and *S. geochroum* of the *Brit. Flora.* The remainder are placed by him among the Sepedoniei, under *Sporotrichum* and another genus which he calls *Physospora.* These genera are very obscurely known, so much resembling mycelia with detached conidia scattered on them.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 346; Fries, *Summa Veg.* pp. 492, 495, 521; Greville, *Sc. Crypt. Flor.* pl. 108. figs, 1, 2.

SPUMA'RIA, Pers.—A genus of Myxogastres (Gasteromycetous Fungi), the peridia of which are divided internally into chambers by ascending folds, and in *S. alba* are either sessile and pass above into torn white laminæ, or are stipitate and divided, and form corniculate peridioles bursting above; the latter is probably the perfect form. The whole plant looks at first like white froth; it grows on grasses &c., generally at a little height from the ground.

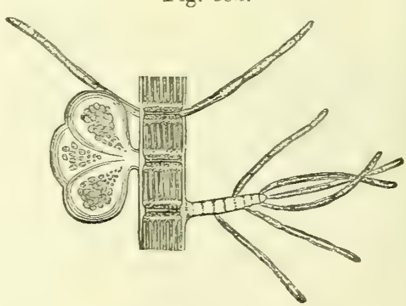
Bibl. Berk. *Brit. Fl.* ii. pt. 2. p. 309; Greville, *Sc. Crypt. Fl.* pl. 267; Sowerby, *Fungi* (*Reticularia*), pl. 280; Fries, *Summa Veg.* p. 449.

SPU'TUM.—We omitted to notice under Expectoration the occurrence of fibrinous casts of the smaller bronchi and pulmonary air-cells in the expectoration of pneumonia. They are best seen on mixing the sputa with water, forming dichotomous cylinders with rounded enlargements. They consist of fine filaments, and are mostly covered with granule-cells, and are generally met with between the third and the seventh day.

Bibl. Remak, *Diagnost. u. pathogenet. Untersuch. &c.*, or *Edinb. Monthly Journ.* 1847, vii. 350.

SPYRID'IA, Harv.—A genus of Cerami-

Fig. 693.



Spyridia filamentosa.
Fragment with a favella and ramules.
Magnified 25 diameters.

aceæ (Florideous Algæ), containing one British species, *S. filamentosa* (fig. 693), having a dull-red, cylindrical, filiform, much-branched frond, consisting of a chambered tube, the articulations of which are short, and the walls of which are composed of small angular cells. It arises from a broadly expanded disk. The branches are clothed with setaceous ramules. The *favellæ* are stalked, gelatinous, and lobed, surrounded by a few ramules, and contain two or three masses of spores. The *tetraspores* occur attached to the ramules. *Antheridia* have not yet been observed.

BIBL. Harvey, *Brit. Mar. Alg.* p. 166, pl. 22 D.

SQUAMA'RIA, DC.—A genus of Placodei (Lichenacei).

Char. Thallus radioso-laciniate, often radiate. Apothecia lecanorine. Spores colourless, ellipsoid, simple. Paraphyses distinct. Spermatia aciculari-cylindrical, long, or ovate. On earth in limestone districts.

BIBL. Leighton, *Brit. Lich. Flora*, p. 171.

SQUAMEL'LA, Bory, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes four, frontal; foot forked.

1. *S. oblonga* (Pl. 35. fig. 29). Carapace depressed, elliptical, or ovate-oblong, hyaline; toes slender, long. Aquatic; length 1-216".

2. *S. bractea.* Toes short and thick. Aquatic.

BIBL. Ehr. *Infus.* p. 479; Pritchard, *Infusoria.*

SQUAMULINA, Schultze.—An obscure, small, parasitic, scale-like, opaque Foraminifer, probably Nubecularian.

BIBL. Schultze, *Org. Polyth.* 56; Carpenter, *Introd. For.* 67.

STACHYLID'IUM, Link.—A genus of Mucedines (Hyphomycetous Fungi), nearly related to *Botrytis*, distinguished apparently only by the subpedicellate spores. Fries states that these are developed within a fugacious veil (?). BOTRYOSPORIUM *diffusum*, Corda, is included here by most authors. *S. bicolor* and *S. terrestre*, having quaternate sporiferous branches at the upper joints of the erect, simple filaments, grow upon decaying herbaceous plants and rotten sticks.

BIBL. Berk. *Brit. Flora*, ii. pt. 2. p. 341; Fries, *Summa Veg.* p. 490; Greville, *Sc. Crypt. Flor.* pl. 257.

STAINING TISSUES.—Some remarks upon the staining of tissues for microscopical investigation were made in art. DYEING, and some formula given and reagents mentioned. Tissues and structures are endeavoured to be stained by colouring-matters, either when their histological elements are comparatively inseparable, or when it is supposed to be impossible to distinguish some particular ones from others by ordinary manipulation. Some elements become coloured by certain dyes, and others do not; or different elements are differently coloured by the same reagent. Thus when the undifferentiated protoplasm will remain uncoloured, the nucleus of a cell will be coloured; whilst the medullary matter of a nerve remains uncoloured the axis-cylinder may be beautifully tinted. Beale states that what he calls germinal or living matter, bioplasm, and which is the structureless undifferentiated protoplasm of other physiologists, possesses an acid reaction after death. Hence, if an alkaline solution of colouring-matter, from which the colour may be precipitated or fixed by an acid, be caused to pass into germinal matter which has not undergone decomposition, the alkali is neutralized and the colour is retained. He considers that it is precipitated in a state of very minute subdivision, or combined with some of the constituents of the germinal matter to form a compound insoluble in weak acids. The tissue or formed material being bathed with an alkaline fluid does not take the colour; and hence by carrying out the process with due care the germinal or living matter may always be coloured, while the formed material or tissue remains perfectly colourless.

It is true, nevertheless, that all the histological elements may gradually be stained of the same colour; and this is perfectly evident in sections of the spinal cord which have been hardened with chromic acid and stained with Beale's solution of carmine for a long time. The only tissues not stained are those which, thanks to the chromic acid and the subsequent clearing agents, no longer exist; the medullary sheath of the nerves for instance. What may be the molecular condition of the staining agent when precipitation has taken place is of no very great moment; but it is manifestly necessary to remember that the staining agents may be divided into two groups: 1. those colouring-matters which like carmine give their proper or the same absorption colours to certain tissues; 2. those like chloride of gold, which has a pale yellow

tint, and which under the influence of light and of other reducing agents, deposits a salt of gold with a purple tint, and like nitrate of silver solution, which is colourless, but which is decomposed and reduced to an oxide which stains from a brown to a black according to the strength and the light. Secondary decompositions determine the colouring in the second series; and therefore other matters than those of the tissues and structures desired to be stained may be present and may interfere with the result. Hence the extraordinary discrepancies in the results of the labours of different observers, such, for instance, as may be read with much advantage in the essay on synovial membranes by E. Albert in Stricker's 'Human and Comparative Histology.' The first series includes such colouring-matters as carmine, indigo-carmine, saffron, aniline blue, fuchsine, magenta, logwood, picric acid, common ink, and Judson's dyes. Gerlach used a concentrated solution of carmine in ammonia, and placed the sections of brain and spinal cord, previously hardened by solution of chromic acid, in the carmine solution for ten or fifteen minutes. They were then well washed in water and treated with acetic acid; subsequently the water and acid were removed by absolute alcohol; and the preparations were then mounted in Canada balsam. Afterwards he found that better results were obtained by using dilute solutions of carmine and ammonia—for instance, two or three drops of the ammoniacal solution to an ounce of water. He advised also maceration in this solution for two or three days. Beale's carmine fluid for staining germinal matter is made as follows:—

Carmine	10 grains.
Strong liquor ammoniæ	$\frac{1}{2}$ drachm.
Price's glycerine	2 ounces.
Distilled water	2 ounces.
Alcohol	$\frac{1}{2}$ ounce.

The carmine in small fragments is to be placed in a test-tube and the ammonia added to it. By agitation and heat the carmine is soon dissolved; then the solution is boiled for a few minutes and allowed to cool. After an hour any excess of ammonia will have escaped. The glycerine and water may then be added and the whole filtered. The clear fluid is to be kept in stoppered bottles; and should any carmine be precipitated, a drop or two of liquor ammoniæ should be added. Care should be taken that the solution and the tissue to be stained have not too alkaline a reaction; otherwise the staining will be too intense, and some of the tissue surrounding the germinal matter will be destroyed. The permeating power of the fluid is increased by the addition of alcohol and water. This is a most valuable staining agent, but requires care. Frey's solution, and that of carmine and borax, have been noticed in art. Dyeing, p. 260. Thiersch recommends:—carmine 1 part, caustic ammonia sol. 1 part, distilled water 3 parts; the solution is to be filtered; oxalic acid 1 part, distilled water 22 parts. One part of the carmine solution is to be mixed with 8 parts of the oxalic acid solution, and 12 parts of absolute alcohol are to be added. Should the solution turn out orange-coloured, more ammonia should be added. Beale has shown that if the germinal matter be rendered alkaline in the first instance by soaking the mass in a weak solution of ammonia, colouring solutions of an acid reaction may be used. He proceeds as follows:—An alkaline solution was injected into the vessels; and after allowing 12 hours or more for the tissues to become thoroughly permeated, the finest prussian blue fluid was introduced. This is formed of common glycerine 1 oz., spirits of wine 1 oz., ferrocyanide of potassium 12 grains, tincture of sol. of perchloride of iron 1 drachm, water 4 oz. The ferrocyanide is to be dissolved in water and glycerine 1 oz., and the tincture of the sesquichloride is to be added to this solution. Then the spirit and water are to be added. The blue solution was found to pass into the very substance of the germinal matter, which was tinged much more deeply than the surrounding substance. Frey gives the following formula for Thiersch's blue staining fluid:—Oxalic acid 1 part, distilled water 22 parts, indigo-carmine as much as the solution will take up. Another solution of oxalic acid and water in the same proportion is required; and one volume of the first solution is mixed with two volumes of the last and nine of absolute alcohol. An aniline-blue solution may be made as follows:—Soluble aniline blue $\frac{1}{2}$ grain, distilled water 1 oz., alcohol 25 drops. This fluid is not acted on by acids or alkalies. Magenta colours rapidly, and hence it is very useful; but its effects are not permanent. Rutherford gives the following formulæ:—Crystallized magenta 1 grain, absolute alcohol 100 minims, distilled water 5 oz. This is used for the tissues generally; and the following is for blood-corpuscles:—Crystallized reagents 1 part, rectified spirit 50

parts, distilled water 150 parts, glycerine 200 parts.

Very often nerve does not stain readily with carmine after hardening in a solution of chromic acid. This may be obviated by placing the section in absolute alcohol for a short time in order to get rid of the water; then it is placed in a solution composed of water 300 to 600 parts, and chloride of palladium 1 part. As soon as a pale straw-colour is seen on the section, it may be removed from the solution and washed, and then placed in a strong solution of carmine and ammonia. A very few minutes will suffice to stain the axis-cylinders red and the medullary matter yellow (*Qu. Mic. Jn.* 1872, p. 160).

A blue staining agent is useful for treating specimens of the spinal cord, which is formed by the reaction of molybdate of ammonium, iron filings, and hydrochloric acid (*Qu. Mic. Jn.* 1872, p. 161).

A logwood staining solution, which consists of an ounce of saturated solution of logwood and alum mixed with two drachms of 75 per cent. alcohol, is useful for the nervous elements (*Qu. Mic. Jn.* 1873, p. 87, & *The Lens*, July 1872).

The second series of staining agents comprises especially the chlorides of gold, potassium and palladium, oxide of uranium, nitrate of silver, and osmic acid. In these, except perhaps in the last, a secondary decomposition occurs before the colour is imparted to the tissues; and the *greatest possible care must therefore be taken to allow for the granular or striated condition which such precipitates may assume, and for their collecting in tubes and between tissues.* An excellent formula for the staining of ganglion-cells especially is as follows:—Bichromate of ammonia 1 to 2 per cent. solution in water. Place the fresh nerve-substance in it for 15 or 20 days. Then dip it, after having made sections, in water 10,000 parts. Double chloride of gold and potassium 1 part; wash in hydrochloric acid 1 or 2 parts in 3000 water. Then dip for ten minutes in the following mixture:—Hydrochloric acid 1 part, and 1000 parts of a 60 per cent. solution of alcohol; immerse in absolute alcohol, clear with oil of cloves, and put up in Canada or Dammar balsam. Staining with chloride of gold may be conducted as follows, the object being to stain nerve-fibres:—Chloride of gold ½ part, distilled water 100 parts. Place pieces of fresh tissue in this for a few minutes until they become tinged with yellow, then in dilute acetic acid (1 to 2 per cent.), or in concentrated tartaric acid solution for a few (10–15) minutes. Expose to light until a violet colour appears. Mount in glycerine. There is great uncertainty in the results of this process; but care and experience overcome most of the difficulties and produce magnificent preparations; nevertheless no results are worth recording which are obtainable by this process alone, and which are not the same as those visible with glycerine and carmine staining solutions. The discrepancies of observation of different and equally dogmatic observers are most instructive. In fact in some tissues the gold solution will stain many histological elements (see E. Klein, *Qu. Mic. Jn.* 1872, p. 21, and Moseley, *Qu. Mic. Jn.* 1871, p. 58).

Nitrate of silver for staining epithelial cement in capillaries, lymphatics, &c. The solution must be clear and weak, and of 1 part nitrate of silver to 200, 400, or 800 of distilled water. The fresh tissues must be macerated in the solution for one to three minutes, and then in a solution of dilute acetic acid (1 to 2 per cent.) for a minute or two. Then place in glycerine and expose to the light; or after removal from the nitrate-of-silver solution the tissue should be washed in distilled water, or in a weak solution of common salt before exposure to light.

For the examination of certain structures, for instance the stellate bodies in the cornea, the nitrate of silver must be applied in the solid form. The surface of the cornea is scraped all over with a scalpel, and then the exposed surface is rubbed with the solid caustic for a few seconds, water and common salt (2 per cent.) being then added. The cornea, which should appear white and almost opaque, should be mounted in glycerine (Moseley, *Qu. Mic. Jn.* 1871, p. 56). In examining the centrum tendineum of the diaphragm of any of the smaller mammalia, the part should be placed in the nitrate-of-silver solution and brushed over with a camel's hair pencil and then removed and treated as above. E. Klein's admirable results on the histology of the serous membranes were due partly to his extreme care in staining. He advises pouring serum over the membranes *in situ*, and then placing on the silver solution before removing them and their attachment *en masse*. He inculcates strongly the necessity of not interfering previously with the surfaces to be stained;

and he insists that the staining affects an albuminous intercellular substance in the serous membranes.

Solution of osmic or perosmic acid may be used as a hardening agent, and also as a staining medium. Very weak solutions of never more than 1 per cent., and usually of much less, blacken many tissues freely, but first of all the white substance of Schwann in nerves, and then fat. It is very useful in investigating the minute anatomy of the Invertebrata.

BIBL. Beale, *How to Work*, 4th edit.; Carpenter, *The Microscope*; Stricker's *Hum. & Comp. Hist.*, Intro.; Frey, *Das Mikros. Qu. Mic. Jn. & Mo. Mic. Jn.* passim; Moseley, *op. cit.*; Klein, *Anatomy of Lymph. Syst.* i. 1873; Rutherford, *Practical Course, Qu. Mic. Jn.* 1872; H. Jackson, *Qu. Mic. Jn.* 1874, 139; Giles, Baber, Matthews, White, and others, *Med. Mic. Soc. in Mo. Mic. Jn.* July 1874.

STAMENS.—The fertilizing organs producing the POLLEN, surrounding the pistil in perfect Flowering plants, or occurring alone in the barren flowers of the monœcious and diœcious genera. Stamens present a great variety of interesting points for examination under a simple microscope with a low power, in their forms, appendages, pores, &c. For the compound microscope they afford good material for the study of development of cells in the pollen, the POLLEN-grains themselves, and the spiral-fibrous tissue of their ANTHERS.

STARCH.—This substance, with the exception of the protoplasm the most generally diffused of all the products met with in the interior of vegetable cells, occurs in the form of transparent granules, of varied size and form and in varying quantity, in all classes of plants but the Fungi. It has been stated that it exists sometimes in a diffused or formless condition; but this seems questionable. All starch-grains appear when newly formed as minute spherical bodies, and very many never advance beyond this stage; but a considerable proportion of the grains, in all cases where the starch becomes an important and considerable element in the cell-contents, increase in size, and acquire a more or less definite form, diverging from the spherical, and often characteristic of the particular plant in which the grain is produced. The grains in a single cell mostly vary very much in size, on account of their different degrees of development; but the full-grown characteristic grains of the same species of plant agree tolerably well in size. One of the most remarkable peculiarities of starch is the fact that it assumes a blue colour when iodine is applied to it, which in most cases affords a ready means of detecting its presence. The smallest grains are almost too minute to measure, and even their determination by the application of iodine is sometimes unsatisfactory; the largest grains, such as those of *Canna* and the potato, for example, attain a length of more than 1-400″.

The starch-granule is a definitely organized structure, although its existence in relation to that of the cell is transitory. It consists of assimilated food, deposited in a definite form insoluble in the ordinary cell-sap, through a process of organization analogous to that by which the development of the cell itself is effected. It is related closely to the cellulose structures of the cell-wall through the remarkable secondary layers found in the ALBUMEN of certain seeds, composed of the substance called *amyloid*, which sometimes takes a blue colour when iodine is applied to it, and, like starch, is ultimately dissolved and removed to furnish material for development.

The structure of the starch-granule has formed the subject of much debate, which, however, seems to have originated rather through considerations relating to the development than from a difficulty in observing the complete objects. Very minute granules, as above stated, appear as solid globules; but when the granules acquire appreciable dimensions, concentric lines may be observed, more or less distinctly in different cases, which lines increase in number with the increase of size, in many cases, however, soon becoming excentrical from the preponderating growth of one side of the granule. In freshly extracted granules the original centre mostly appears solid or with a minute black point; but if the starch is dry, the centre appears hollow, sometimes is even occupied by air; and some starch-grains, as in *Iris pallida, florentina*, &c., have a large cavity. If strong alcohol is applied to fresh grains, the abstraction of water likewise produces a hollow in the central point of growth; and in all these cases, cracks not unfrequently run out towards the surface. The point in question, the starting-point of growth, solid or hollow as the case may be, is sometimes called the *hilum* or the *nucleus*: the former term arose out of the mistaken hypothesis of its being

a point of attachment to the cell-wall; the latter term is admissible in a general sense as merely indicative of its precedence in age of the general mass of the grain. It is sometimes asserted that this point or nucleus is a pore or funnel-shaped cavity; but this is altogether a mistake, as may be readily proved by gently roasting a few starch-granules of the potato on a slide, and observing how the expanding air blows up the dextrine into which the starch is changed, in the form of a bubble or bladder. Sometimes small granules occur in the potato with a large cavity and thin walls.

The lines seen in the starch-granules are the boundaries of superimposed layers of its substance; sometimes these are very distinct, sometimes very faint. Often more distinct lines appear at intervals in the series of the same granule (Pl. 37. fig. 21); and in these cases even a thin vacancy, or in the dried granules a stratum of air, seems to exist between the layers. The markings have been described as "folds" on the starch-granules; but their dependence on the existence of the concentric layers is beyond doubt. They are seen in the proper relative positions when the granules are rolled over in all directions beneath the microscope; their relative numbers and forms correspond to the size and stage of development of the granules in the same plant; and other characters connected with the physical structure confirm the conclusions from simple inspection.

Starch is not chemically an individual substance, but consists of two independent substances (isomeric), one of which, granulose, is soluble in saliva, is tinted by iodine, and is dissolved by weak solutions of chromic acid; and the other, cellulose, is not affected by saliva or iodine, and is soluble in solution of cuprate of ammonia, but not in chromic acid solution. These two elements of starch exist in definite layers in the grain.

Starch is usually stated to be unaffected by *cold water*; and this is generally the case; but if the granules of *Tous-les-mois* are crushed before placing them in water, so as to expose the internal substance, the water is sometimes absorbed by the inner layers, and these swell up considerably without the outer layers being affected. When starch-granules are *heated* gradually (*dry*) upon a slide, until some of them assume a yellowish colour, either the air-bubble above-mentioned appears—occasionally with a partial separation of the concentric layers through expansion of the films of air existing between them, while other parts become fused,—or the general shape remains unchanged, and the striæ gradually vanish, becoming melted into a mass, as it were, the starch itself being converted into dextrine. When starch-granules are *heated in water* to the boiling-point, they usually soften and "blow-up" into a large sac, the inner part softening first, and pushing out the more superficial; if the sac bursts, the inner substance sometimes partly escapes in the form of cloudy flocks, but is not dissolved. *Diluted sulphuric acid* acts somewhat in the same manner as hot water; but if stronger acid is allowed to attack the granules locally or partially by flowing in from one side upon the object, very remarkable appearances present themselves: the acid touching certain parts of the granule first, or acting most quickly on softer portions, causes the softening internal layers to expand and bulge out the external layers at particular points (like *herniæ*) until the entire grain is softened, when these coalesce and the whole expands into a thin sac. Gradual action of the acid causes a more uniform expansion, which is usually accompanied by a sudden crack running out from the nucleus into the substance (indicating the abstraction of water?), followed almost immediately by a collapse of the wall above this crack, and a sudden expansion of the whole into a sac or an irregular gelatinous film. *Solution of potash* produces much the same effect as dilute sulphuric acid.

All the above appearances indicate that the starch-granule is composed of concentric "shells" of a substance of the same nature, but less dense and more rich in water in the interior layers, firmer, less hydrated, and more resisting in proportion to the distance from the starting-point of growth or nucleus. With polarized light, moreover, the starch-granule exhibits a black cross, and with a plate of selenite a beautiful coloured system, especially well seen in large grains like those of the potato or *Tous-les-mois*.

But the recent observations of Nägeli and others go to prove that there exists a still greater complication. They find that prolonged treatment with saliva and some other agents will remove the substance coloured blue by iodine, leaving the granule, with its striæ more distinct, capable of resisting acids and alkalies.

Pure starch is coloured blue by iodine,

whether in its natural state or softened by hot water, the depth of the colour depending on the quantity of iodine; where much is added, the colour is almost black. When dilute sulphuric acid has been added previously, the colour is rather purple than blue, especially the faint tinge given at first by weak solution of iodine. When the starch grains are heated dry, the colour given by iodine changes, proportionately to the violence of the action, from blue to purple, red-wine colour, and finally brown. The best application is the solution of iodine in iodide of potassium; and this should be used very weak in investigation of starch.

Starch-granules occur either isolated (Pl. 37. figs. 8 & 21), or in groups (figs. 7, 10, 11) (in the latter case mostly with flat faces, so as to fit together into round, oval, or similar forms), or packed closely in the parent cell in such numbers that they press upon each other and appear like parenchymatous cells (Pl. 37. figs. 3 & 12). In the actively vegetating parts of plants, starch-granules occur very generally imbedded in the green globules called CHLOROPHYLL-granules, either singly or in groups; this is seen especially well in the cells of the Confervaceæ, of the Hepaticæ, the prothallia of Ferns, in the leaves of aquatic plants, such as *Vallisneria*, in autumn, &c. The free granules occur more particularly in the colourless organs of plants—in tubers, rhizomes, roots and the cambium region in the season of rest, in the endosperm of ovules, or the ALBUMEN or cotyledons of seeds, &c. The parenchymatously grouped granules are found in the albumen of seeds, especially of maize and rice. The comparison of the states and of the course of development of the crowded granules of maize throws much light upon the manner in which starch-granules are formed.

In the first place, two rival doctrines exist as to the order of development of the parts of the granule. Most authors assert that the granules grow by the superposition of layers from within outwards, consequently that the outermost layers are the youngest. Other authors, especially Nägeli, comparing the granule to a cell, assert that the layers are formed internally, the older ones expanding *pari passu* to make room for them. There can be no doubt that the first view is correct. In the next place a variety of notions have been put forth as to the origin of the starch-granule and its relation to the rest of the contents of the cell, especially the chlorophyll. It is curious to note the error into which earlier observers fell from the want of the guiding thread furnished by a knowledge of the function of the protoplastic structures connected with the primordial utricle. The idea that the starch-granule sprouted out from the cell-wall corresponded with the original view of the origin of the septum in cell-division, while the hypothesis that starch is developed from chlorophyll, and the contrary notion that starch-granules form the nuclei of chlorophyll-granules, both rest on actual phenomena, in which, however, the chlorophyll proper (that is, the mere green colouring-matter) bears no important share.

The development of the starch-granule is very beautifully illustrated in the gradual ripening of the seeds of Maize; and in imperfect seeds, different parts of the same grain often afford various stages of growth. The figs. 1–4 of Pl. 37, show the gradual formation of the starch-granules by deposition from the internal surface of *vacuoles in the protoplasm* filling the cell, exactly in the same way as the primordial utricle secretes cellulose layers upon its outer surface. Fig. 28 shows minute starch-granules originating in the same way in the protoplasm-current connected with the nucleus in the white lily; and Crüger, who first published this view in a decided form, has shown that the large granules, with an excentric "hilum," originate in a similar position, and owe the excentricity of their form to the fact of their remaining imbedded at one (the thicker) end in the protoplasmic threads of the primordial utricle, while the small free end is gradually pushed out further from the nutrient mass. The existence of starch-granules in chlorophyll-masses is thus clearly enough accounted for, now that we know the chlorophyll-globules to consist of masses of protoplasm coloured green by the presence of an extremely small quantity of a substance acquiring a green colour under the influence of light. Starch originates in vacuoles in this as in any other protoplasm. The *groups* of granules are formed through the simultaneous origin of a number, in vacuoles excavated in one large globule of chlorophyll or colourless protoplasm. We have traced this in the fronds of the Hepaticæ. These brief remarks must suffice on this part of the subject; and further details must be sought in the very copious literature which exists.

It remains to speak of the diversities of

form and size of the large and perfect granules in different plants. A glance at Plate 37 will give some idea of these; and an inspection of the individual figures will show how remarkably the characteristic forms may vary in nearly related plants, even genera of the same family, as is the case with the ordinary Cereal grains. Thus in Maize (figs. 1 to 6), where the small grains are, as usual, originally roundish or oval (fig. 6), they gradually press upon one another and become polygonal—in the cells of the centre of the grain, where they are less densely packed, remaining with obtuse edges and angles (fig. 5), in the cells of the horny outer part of the grain, where they adhere more or less firmly together, forming angular parenchymatous masses (fig. 3). The central cavity is large here. In the grain of Wheat we find delicate, transparent, lenticular granules (fig. 8), the striæ faint; in Barley (fig. 9) they are more irregularly discoid, with a thickened edge, the striæ obscure; while in the Oat (fig. 10) the granules are of very small size, but of angular forms and packed together in large numbers, so as to form roundish masses with a smooth surface, which readily break down into their components when pressed; the separate segments all exhibit their separate black crosses in polarized light. In Rice (fig. 12) we find somewhat similar conditions to those in Maize; but the granules are much smaller and more firmly united, whence the gritty character of rice-flour. In the Potato the starch-granules are found larger (fig. 21) than any of the above; they are numerous and loosely packed in the cells (fig. 20). Among the more remarkable forms of starch are the large grains of the *Cannæ* (fig. 25), *Musa* (fig. 24), and most of the Zingiberaceæ (fig. 19). Some East-Indian Arrow-root (fig. 18) has compound grains of large size (mostly detached in the prepared farina). True West-Indian Arrow-root, from *Maranta arundinacea*, is represented in fig. 26. Various other kinds are illustrated in Pl. 37. *Dieffenbachia Seguina* (Araceæ) has remarkable lobed granules.

Starch-granules are usually isolated by slicing the tissues in which they exist, and washing them out. When they are to be observed *in situ*, either delicate transparent structures (as in the Cryptogamia) must be selected, or sections very carefully made. The cells filled with starch of the potato (Pl. 37. fig. 20), &c., may be isolated by macerating the structures in water for a day or two. Starch-granules may be preserved for a certain time in glycerine; but they are, perhaps, best taken fresh from a store of dry granules, when required for examination.

BIBL. Martin, *Phil. Mag.* 2nd ser. iii. p. 277; Busk, *Microsc. Trans.* 2nd ser. i. p. 58; Allman, *Micr. Journ.* ii. p. 163; Crüger, *Bot. Zeit.* xii. p. 41 (1854) (*Micr. Journal*, ii. p. 173); Kützing, *Grundz. d. phil. Bot.* i. p. 261; Lindley, *Introd. to Botany*, 2nd ed. p. 111; E. Quekett, *Ann. Nat. Hist.* xvii. p. 193; Raspail, *Ann. des Sc. Nat.* vi. (1825) and vii. (1826); Grundy, *Pharmaceutical Journal*, April 1855; Caspary, *Ueb. Hydrillen, Jahrb. f. wiss. Botanik*, i. p. 448; Trécul, *Ann. des Sc. Nat.* 4 sér. x.; Henfrey, *Elem. Course* (Masters).

STAURAS'TRUM, Meyen.—A genus of Desmidiaceæ.

Char. Cells single, constricted at the middle; end view angular or circular, with a lobato-radiate margin, or rarely compressed with a process at each end.

Sporangia generally spinous and often globose.

Many British species.

1. *S. dejectum* (Pl. 10. fig. 26). Segments smooth, lunate or elliptical, constricted portion very short; end view with inflated awned lobes. Common; length 1-830".

2. *S. margaritaceum* (Pl. 10. figs. 28, 29). Segments rough, tapering at the constriction, and with short lateral processes; end view with five or more short, narrow, obtuse rays. Length 1-1176".

3. *S. gracile* (Pl. 10. fig. 30). Segments rough, elongated on each side into a slender process terminated by minute spines; end view biradiate. Length 1-770 to 1-540".

BIBL. Ralfs, *Brit. Desmid.* p. 119; Rabenht. *Fl. Eur. Alg.* iii. p. 196; Archer and Dixon, *Qu. Mic. Jn.* viii. p. 77.

STAURIDIUM, Duj.—A genus of Athecate Hydroida.

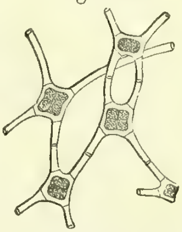
Char. Stems simple or branched, rooted by a creeping filiform stolon; polypites borne at the summit of the stems with several verticils of capitate tentacula disposed in the form of a cross. Gonozooid: umbrella deep bell-shaped, manubrium with a simple mouth, radiating canals and marginal tentacles four, undulated with clusters of thread-cells, and springing from ocellated bulbs.

BIBL. Hincks, *Brit. Hyd. Zooph.* p. 67.

STAUROCAR'PUS, Hassall (*Staurospermum*, Kütz.).—A genus of Zygnemaceæ (Confervoid Algæ), growing in (boggy)

freshwater pools; distinguished by the remarkable quadrate spore formed in the cross branch produced by conjugation. Hassall enumerates six species. He speaks of (but does not describe or figure) the spores of *S. cærulescens* filled with "zoospores." Thwaites, however, saw the spores of *S. gracilis* resolved into four portions; and possibly these may become converted into zoospores like the spores of BULBOCHÆTE. Probably, however, they germinate directly, as in SPIROGYRA.

Fig. 694.



Staurocarpus gracilis.
Conjugating filaments with spores (zygospores).
Magnified 100 diameters.

S. gracilis (fig. 694 and Pl. 5. fig. 16).

BIBL. Hassall, *Brit. Fr. Alg.* p. 176; Kützing, *Sp. Alg.* p. 437; *Tab. Phyc.* v. pls. 8 & 9; Thwaites, *Ann. Nat. Hist.* xvii. p. 262; Ralfs, *Brit. Desmid.* p. 146; Al. Braun, *Verjüngung, &c.* (*Ray Soc. Vol.* 1853, p. 287).

STAUROGO'NIA, Kütz.—A genus of Unicellular Algæ.

Char. Mass cubical, with cells arranged in groups of 4, 8, and 16. Propagation by immobile gonidia arising from repeated division of the cell-substance.

BIBL. Rabenh. *Fl. Eur. Alg.* iii. p. 80.

STAUROGRAMMA, Rabenh.—A genus of Diatomaceæ.

Char. Like STAURONEIS, but with decussating striæ and prominent knots at the intersections.

BIBL. Pritchard, *Infus.* p. 915.

See STAURONEIS.

STAURONE'IS, Ehr.—A genus of Diatomaceæ; includes also *Staurostigma* and *Stauroptera*.

Char. Frustules resembling those of *Navicula*, but the median nodule expanded into a transverse band or stauros.

Striæ resembling those of *Navicula*, or intermediate between those of *Navicula* and *Pinnularia*; often invisible by ordinary illumination.

The species or forms are numerous.

S. phœnicenteron (Pl. 11. fig. 43). Valves lanceolate, gradually attenuated towards the somewhat obtuse ends; stauros reaching the margins of the valves; striæ faint. Aquatic; common; length 1-170''.

S. pulchella (Pl. 11. fig. 44, 45). Valves oblong, ends obtuse; frustules in front view broadly linear, constricted in the middle, and rounded-truncate at the ends; striæ distinct; stauros not reaching the margins. Marine; length 1-70''.

BIBL. Ehrenb. *Ber. d. Berl. Akad.* 1843; Kütz. *Bacill.* p. 104, and *Spec. Alg.* p. 89; Rabenh. *Fl. Eur. Alg.* i. p. 244.

STAUROSPER'MUM, Kütz. (1843) = STAUROCARPUS, Hassall (1845).

BIBL. Rabenh. *Fl. Eur. Alg.* iii. p. 259.

STEARIC ACID.—The crystals of this fatty acid are represented in Pl. 7. fig. 16.

BIBL. See that of CHEMISTRY.

STELLATE CELLS.—Cells with numerous prolongations, which may or may not anastomose, found in connective tissue and around the capillaries.

BIBL. Stricker, Rollett, and Eberth, *in Stricker's Hum. & Comp. Hist.* i.

STEMONI'TIS, Gled. — A genus of Myxogastres (Gasteromycetous Fungi), consisting of little, somewhat stamen-shaped plants, either separate or fasciculated, growing on rotten wood, &c. They appear at first in the form of a mucilaginous flocculent expansion (fig. 695), from which the

Fig. 695.

Stemonitis ferruginea.
Mycelium overgrowing decaying pine-leaves.

membranaceous peridia grow up (fig. 696). Many of these remain abortive; others are

Fig. 696.

Stemonitis ferruginea.
Immature (fasciculate) peridia arising from the mycelium.

raised upon stalks, ripen, and, on the separation of the fugacious peridium, display themselves somewhat in the form of DIA-

CHÆA, but with a bristle-like columella and no remains of the peridium. The flat, cylindrical or globose, reticulated capillitium is penetrated partly or through its whole length by a columella continuous with the peduncle; the spores are interspersed in the reticulations of the capillitium. Capillitium and spores mostly of blackish colour. There are numerous British species; *S. fusca* is common. See ENERTHENEMA and DIACHÆA.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 317; *Ann. Nat. Hist.* i. p. 257, vi. p. 431, 2 ser. v. 366; Greville, *Sc. Crypt. Flor.* pl. 170; Fries, *Summa Veg.* p. 455; *Syst. Myc.* iii. p. 156.

STENOC'YBE, Nyl.—A genus of parasitic Micro-lichens found on the thallus of *Thalotremia* and *Graphis* = *Sphinctrina*, Leighton.

BIBL. Lindsay, *Q. Mic. Jn.* 1869, p. 146.

STENOGRAM'ME, Harv.—A genus of Rhodymeniaceæ (Florideous Algæ), containing one very rare British plant, *S. interrupta*, characterized by stalked, flat, fan-shaped fronds, more or less divided dichotomously into riband-like lobes, 3–5″ high, of a clear pinky-red colour. It is composed of a central layer of large globular cells, with a kind of rind of small cells. The *conceptacles* form a sort of sorus or dark line resembling a rib, up the centre of each fertile lobe. Tetraspores and antheridia unknown.

BIBL. Harvey, *Brit. Marine Alg.* p. 123, pl. 15 D.

STENTOR, Oken.—A genus of Infusoria, of the family Bursarina.

Char. Body conical or trumpet-shaped, free, or sessile and attached by the narrow base; covered with cilia; anterior portion widened and fringed with a marginal row of longer cilia, with a spiral row of cilia extending from it to the mouth. Aquatic.

These Infusoria are among the largest and the most beautiful of the class. The body is very contractile and liable to variation in form, often becoming ovate, oblong, or globular. The so-called nucleus is moniliform or strap-shaped. The encysting process has been noticed in some of the species.

According to Lachmann, in *S. Mülleri*, *polymorphus*, and *Rœselii*, near the plane of the ciliary disk is a large contractile vesicle; from which a longitudinal vessel runs to the posterior extremity of the animal, and an annular vessel round the ciliary disk, close under its row of cilia; the longitudinal vessel has several dilatations.

S. Mülleri (Pl. 25. fig. 3). Body colourless unless from containing foreign coloured particles, with a fringe of cilia or a ciliated crest extending from the mouth to near the middle of the body; nucleus moniliform. Length 1-24″. = *S. Rœselii* = *S. polymorphus*.

Dujardin places this genus in the family Urceolarina.

BIBL. Ehr. *Infus.* p. 261; Stein, *Infus.*, passim; Pritchard, *Infus.* p. 581; Clap. et Lach. *Etudes*, p. 222.

STEPHANOC'EROS, Ehr.—A genus of Rotatoria, of the family Floscularıæa.

Char. Eyes single; rotatory organ divided into five tentacle-like lobes, furnished with whorls of vibratile cilia; body attached by the base to a cylindrical hyaline carapace.

S. Eichhornii (Pl. 35. fig. 25). The only species. Aquatic; length 1-36″. This beautiful animal uses the lobes of the rotating organ to catch its prey, in the manner of *Hydra*. At *a* (fig. 25) are seen the tremulous bodies, above which is a row of roundish globules, called by Ehrenberg nervous ganglia.

BIBL. Ehr. *Infus.* p. 400; Pritchard, *Infus.* p. 668; Cubitt, *Mo. Micr. Jn.* iii. p. 240.

STEPHANODIS'CUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules discoidal, single; valves circular, alike, not areolar (under ordinary illumination), and with a fringe of minute marginal teeth. Aquatic.

S. berolinensis has the valves finely radiate, with mostly thirty-two teeth, and is 1-1150″ in diameter. *S. Niagaræ* (Pl. 43. fig. 26); *S. lineatus* (fig. 27); *S. sinensis* (fig. 28); *S. Ægyptiacus* (fig. 29); *S. Bramaputræ* (fig. 29*).

BIBL. Ehrenb. *Ber. d. Berl. Akad.* 1845, lxxii.; Kütz. *Sp. Alg.* p. 21; Rabenht. *Fl. Eur. Alg.* i. p. 36.

STEPHANOGO'NIA, Ehr.—An obscure genus of fossil Diatomaceæ.

Char. Frustules resembling those of *Mastogonia*, but with the apices of the valves truncate, angular, and spinous.

Two species found in Bermuda and North America. *S. polygona* (Pl. 43. fig. 30).

BIBL. Ehrenb. *Ber. d. Berl. Akad.* 1844, p. 264; Kütz. *Sp. Alg.* p. 26; Pritch. *Infus.* p. 814.

STEPHANO'MA = Pandorina.

Bibl. Pritchard, *Infus.* p. 529.

STEPH'ANOPS, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes two, frontal, foot forked; carapace depressed or prismatic; anterior part of body expanded so as to form a frontal hood.

Jaws each with a single tooth.

S. cirratus (Pl. 35. fig. 28). Carapace with two posterior spines. Aquatic; length 1-240''.

S. muticus has the carapace without spines posteriorly, and the eyes have not been recognized; whilst *S. lamellatus* has three posterior spines.

Bibl. Ehr. *Infus.* p. 478; Pritch. *Infus.* p. 699.

STEPHANOPYX'IS, Ehr.—A genus of Diatomaceæ = *Pyxidicula*, in part.

STEPHANOSI'RA, Ehr.—A genus of Diatomaceæ.

Char. Frustules united into a short filament, disk with radiating series of minute puncta and a marginal crown of teeth. Allied to *Stephanodiscus* and *Melosira*. On trees.

Bibl. Pritchard, *Infus.* p. 823.

STEPHANOSPHÆ'RA, Cohn.—A genus of Volvocineæ (Confervoid Algæ), not yet observed in Britain. *S. pluvialis* is nearly related to *Pandorina*, consisting of a large hyaline globe with eight biciliated green cells, placed at equal distances on the equator.

Bibl. Cohn, *Sieb. & Köllik. Zeitschr.* iv. p. 77 (1852) (*Ann. Nat. Hist.* 2nd ser. x. p. 321, pl. 6); *Mic. Jn.* vi. p. 131; Rabenh. *Fl. Eur. Alg.* iii. p. 100; Archer, *Qu. Mic. Jn.* 1865, p. 116.

STEREOCAU'LON, Schreb.—A genus of Lichenacei, so called from the solid character of the branched bushy thallus. *S. paschale*, the most distinct species, is abundant on rocks and stones on mountainous districts. The thallus is greyish and rough, the apothecia conglomerated, blackish brown. The spermogonia occur in little brown heads, near the apothecia.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 237; Tulasne, *Ann. d. Sc. Nat.* 3 sér. xvii. p. 197; *Engl. Bot.* pl. 282; Leighton, *Brit. Lich. Flora*, p. 76.

STEREONE'MA, Kütz.—A supposed Alga of the family Phæonemeæ (Kützing), stated by Cohn, however, to consist of the decaying stalks of Anthophysa.

Bibl. Kütz. *Sp. Alg.* p. 160.

STE'REUM, Fr.—A genus of Auricularini (Hymenomycetous Fungi), characterized by its coriaceous substance, even hymenium without bristles, as in *Hymenochæte*.

The species are numerous, amongst which *Stereum hirsutum* is one of our commonest Fungi.

Bibl. Fr. *Ep.* p. 548; Berk. *Outl.* t. 17. f. 7; Cooke, *Handb.* p. 316.

STERIG'MATA—The term applied by Tulasne to the filaments forming the pedicels of the spermatia in the Fungi (Pl. 20. figs. 2, 3).

STICHID'IA.—Pod-shaped processes of the fronds of Florideous Algæ, containing the tetraspores imbedded in them (fig. 157, p. 225).

STICHOCHÆ'TA, Clap. et Lach.—A genus of Oxytrichina (Infusoria Ciliata). For *Char.* see Oxytrichina, p. 571.

STICHOSTE'GIA, D'Orb. (Rhabdoidea, Schultze).—D'Orbigny arranged all Foraminifera having uniserial or linear growth under this head as an Order; but, besides the many straight *Nodosarinæ*, there are several rectilinear forms of other genera belonging to different Natural Orders, as *Lituola*, *Pavonia*, *Articulina*, &c.

STICHOT'RICHA, Perty.—A doubtful genus of Infusoria.

Bibl. Pritchard, *Infus.* p. 644.

STIC'TA, Ach.—A genus of Parmeliei (Gymnocarpous Lichens), with a tough foliaceous thallus, growing over rocks and trunks of trees, mostly in mountainous districts. *S. pulmonaria* forms large shaggy fronds of olive-green colour when fresh, pale-brown when dry, pitted and reticulated; the apothecia mostly marginal, red-brown. The spermogonia of this genus occur scattered on the upper surface, mostly near the ends of the lobes.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 208; Tulasne, *Ann. d. Sc. Nat.* 3 sér. xvii. p. 169, pl. 1; *Engl. Bot.* pl. 572; Leighton, *Brit. Lich. Flor.* p. 118.

STICTE'I, Fries.—A group of Helvellacei (Ascomycetous Fungi), containing several genera of plants, growing on wood, branches of trees, &c., bursting through from beneath the bark when mature. *Stictis* (*Cryptomyces*, Berk.; *Propolis*, Fr., *S. Veg. versicolor* (figs. 697–699)) is common on wood; the upper surface of the open fruit is white, and at length mealy.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 214; *Ann. Nat. Hist.* vi. p. 359; Fries, *Summa Veg.* p. 372.

Fig. 697.

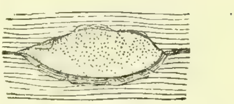
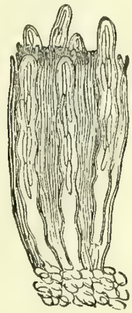


Fig. 698.

Fig. 699.



Stictis versicolor.

Fig. 697. An open disk, emerged on the surface of wood, having an irregular border.
Fig. 698. Vertical section of the same.
Magnified 20 diameters.

Fig. 699. Asci and paraphyses from the last. Magnified 200 diameters.

STIC'TINA, Nyl.—A genus of Parmeliei (Lichens).

Char. Thallus variously lobed or laciniato-lobate. Rhizinæ simple. Stratum gonidiale consisting of granula gonima of a dark blue-green colour.

BIBL. Leighton, *Brit. Lich. Flor.* i. p. 114.

STICTODIS'CUS, Grev.—A genus of Diatomaceæ.

BIBL. Grev. *Mic. Trans.* 1865, p. 98.

STIGEOCLO'NIUM, Kütz.—A genus of Confervoid Algæ, doubtfully referred to Confervaceæ, growing mostly in brooks, and composed of delicate branched filaments, drawn out into delicate hyaline points; attached to stones and forming masses of a sinuous or lubricous character. The jointed filaments are composed of short cells, possessing bright green contents; the entire contents of a cell are converted into a single spore (with four cilia) and discharged (Pl. 5. fig. 5); and the cell-wall is so delicate that it generally vanishes at the same time. Many species are described by Kützing, formerly regarded as members of the genus DRAPARNALDIA, which differs in the number of spores produced in each cell, and in possessing large primary filaments with lateral tufts of delicate ones, resembling those of *Stigeoclonium* (fig. 179, p. 259).

S. protensum (Pl. 5. fig. 5). Tufts of filaments 1-36 to 1-60″ high, very much branched and elongated; primary filaments 1-1800″ in diameter, joints equal or three times as long (*Drap. condensata,* Hassall, pl. 11. fig. 1).

BIBL. Kütz. *Sp. Alg.* p. 352; *Tab. Phyc.* iii. pls. 1–11; Hassall, *Brit. Fr. Alg.* fig. 118; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 223, pl. 18; Rabenh. *Fl. Eur. Alg.* iii. p. 375.

STIG'MA.—The part of the pistil of Angiospermous Flowering Plants, upon which the pollen rests to produce its pollen-tubes, and where the orifices exist leading to the cavity of the ovary. It is situated either at or near the summit of the style or its branches; or, when this is absent, it is sessile on the ovary. The surface of the stigma is clothed with papilliform or short tubular cells, from which a tenacious secretion exudes at the period when the ovules are prepared to receive the pollen-tubes. Attached by this adhesive fluid and often grasped by the papillæ the pollen-grains produce their tubes, which make their way between the papillæ to descend through the conducting tissue of the style to the placenta (Pl. 32. fig. 30). These papilliform cells in a young state often form favourable subjects for the study of the protoplastic cell-contents, and also of the fluid colouring-matter. The forms of the stigma are exceedingly varied and sometimes very elegant; and some of those covered with coloured hairs form beautiful microscopic objects. In the order Compositæ, its characters are used for the systematic division of the numerous genera.

STIGMAPH'ORA, Wallich.—A genus of Diatomaceæ.

Char. Frustules free, naviculoid; valves lanceolate, loculate; loculi with central and marginal puncta. Marine. India.

BIBL. Wallich, *Trans. Mic. Soc.* viii. p. 43; Rabenht. *Fl. Eur. Alg.* i. p. 258; Pritchard, *Infus.*

STIG'MATA OF ANIMALS. See SPIRACLES.

STIGMATID'IUM, Mey.—A genus of Graphidei, Lichenacei.

Char. Apothecia brownish, punctiform or elongate, immersed, hypothecium colourless.

BIBL. Leighton, *Brit. Lich. Flora,* p. 389.

STIGONE'MA, Ag.—A supposed genus of Scytonemeous Oscillatoriaceæ (Confervoid Algæ), founded upon what has proved to be the thallus of a genus of Lichens. See EPHEBE.

BIBL. Rabenht. *Fl, Eur. Alg.* ii. p. 291.

STILBA'CEI.—A family of Hyphomycetous Fungi, growing upon decaying animal or vegetable matter, or on bark or leathery leaves. Characterized by a receptacle com-

posed of conjoined filamentous or hexagonal cells and spores borne singly on the apices of free filaments, forming a gelatinous mass. Some of the Fungi here included are heterogeneous and imperfectly studied; for example, *Tubercularia* and *Fusarium* are apparently only imperfect states of other Fungi, while the more distinct genera appear to be referable to the family Dematiei.

Synopsis of British Genera.

1. *Stilbum.* Receptacle stalked at the base, clavate or capitate at the summit, composed of coalescent, densely crowded, parallel filaments; spores simple, arising singly at the apices of free filaments.

2. *Atractium.* Stem firm. Head subglobose, spores fusiform, elongated.

3. *Myrothecium.* Receptacle at length marginate. Spores diffluent, oblong, forming a flat or slightly convex, dark green stratum.

4. *Tubercularia.* Receptacle wart-shaped, globular or stalked, fleshy, composed of continuous sterile, and thread-like beaded fertile filaments. Finally indurated, floccose, with the spores scattered over it, or falling into powder.

5. *Periola.* Receptacle cellular, sessile; fertile filaments abbreviated, torulose, mixed with septate lax sterile filaments.

6. *Volutella.* Receptacle wart-like, cellular, compact, with long, rigid bristles; spores spindle-shaped, septate, on continuous short filaments, arising all over the receptacle.

7. *Fusarium.* Receptacle wart-like, cellular, gelatinous; spores spindle-shaped, simple, somewhat curved, borne on simple filaments arising all over the receptacle, and forming a discoid stratum.

8. *Illosporium.* Receptacle wart-shaped, subgelatinous, diffluent; spores simple, pellucid, generally with a hyaline envelope, borne on short filaments.

9. *Epicoccum.* Receptacle wart-shaped, cellular, for the most part seated on an effused patch; spores four-sided, cellular, attached singly to very short, continuous filaments.

10. *Ægerita.* Spores irregular, disposed in short moniliform threads at the apices of flexuous, branched, radiating, compacted peduncles.

Bibl. Berkeley, *Crypt. Botany*, p. 311.

STILBOS'PORA, Pers. — A supposed genus of Melanconiei (Coniomycetous Fungi), but apparently only consisting of stylosporous fruits of *Sphæriæ.* These grow upon wood, sticks, &c., breaking forth on the surface without any distinct perithecium, consisting of a nucleus composed of agglutinated (septate) stylospores (see Sphæria).

Fig. 700.

Stilbo spora macrosperma. Group of conceptacles breaking forth on a fragment of wood; nat. size. The detached spores on the right-hand magnified 150 diameters.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 356; *A. N. H.* vi. p. 355; *Hooker's Lond. Jn. of Bot.* iii. p. 322; Fries, *Summa Veg.* p. 508; Fresenius, *Beitr. z. Myc.* Heft ii. p. 63; Tulasne, *A. d. Sc. Nat.* 4 sér. v. p. 109.

STIL'BUM, Tode.—A genus of Stilbacei (Hyphomycetous Fungi).

STILOPH'ORA, J. Ag.—A genus of Sporochnaceæ (Fucoid Algæ), included by some authors among the Dictyotaceæ. There are two British species, *S. rhizodes* and *S. Lyngbyei*, characterized by a branched, filiform, at first solid, afterwards tubular frond, the former 6 to 24″, the latter 2 to 4″ long, arising from a small naked disk. The fructification consists of little wart-like bodies scattered all over the frond, composed of tufts of moniliform filaments, at the bases of which are attached either pyriform unilocular, or tubular septate sporanges. Thuret states that the specimens of *S. rhizodes* found a certain distance above low-water mark appear mostly to bear septate, those always under water simple sporanges, and those in an intermediate position exhibit both. The plants of the first kind are of paler colour than those of the second.

Bibl. Harvey, *Brit. Mar. Alg.* p. 39, pl. 7 C; Greville, *Alg. Brit.* pl. 6; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 238, pl. 38.

STING of Insects.—The well-known sting of the female or so-called neuters of Hymenopterous Insects, as the honey-bee, the humble-bee, the hornet, the wasp, &c., appears to the naked eye to be a single needle-like organ; but when examined under the microscope, it is seen to consist of three pieces—a short, stout, cylindrico-conical outer piece or sheath (Pl. 27. fig. 14 *a*), cleft throughout its length on the under surface and obtuse at the end, within which are partly contained two long elbowed setæ or lancets (Pl. 27. fig. 15, one of them), thickened and furnished with teeth directed backwards near the end of one margin, the other margin sharp and cutting. These setæ

play within the sheath, being partially protrusile and retractile, as is the sheath itself. The poison-apparatus consists of two glandular elongated sacs, either simple (Pl. 27. fig. 14 *e*, *f*), or branched as in the humble bee, &c., and terminating by one (fig. 14 *d*) or two ducts, in a muscular reservoir (fig. 14 *c*), from which an excretory duct runs to the base of the sheath of the sting.

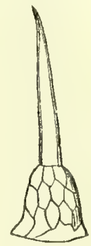
The irritation produced by the sting of one of these insects needs no remark. It does not, however, serve a merely defensive purpose, but is used also to paralyze the prey, so that it may be kept in store for future use.

The sting represents a modified ovipositor.

Bibl. Lacaze-Duthiers, *Ann. des Sc. Nat.* 3 sér. xii. xiv.; Westwood, *Introduction, &c.*; Siebold, *Vergl. Anat.*

STINGS of Plants.—These are epidermal structures, consisting of large hairs, with a bulbous base more or less included in a cellular coat, and attenuated upwards. In the sting of the nettle the apex is expanded into a little bulb, which is broken off when the sting is lightly touched (Pl. 21. fig. 8). Young stings exhibit the Rotation. Stings occur not only in the nettles (*Urtica*), but in the cultivated Loasaceæ (*Loasa*, *Bartonia*, &c.), and of much larger size in some exotic Urticaceæ and Euphorbiaceæ.

Fig. 701.



Stinging hair of Nettle. Magn. 20 diams.

See Hairs, page 366.

STOMACH.—The glands which secrete

Fig. 702.

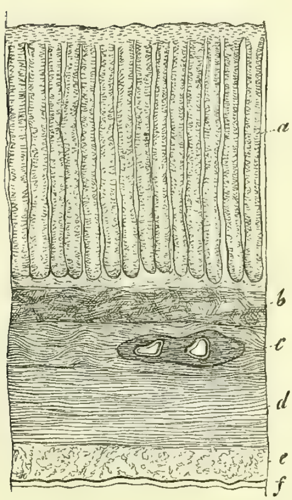


Fig. 703.

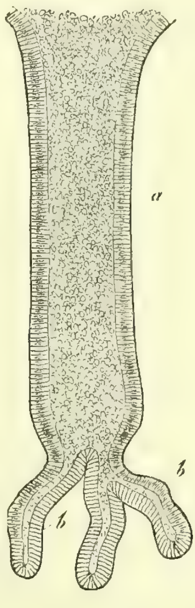


Fig. 704.

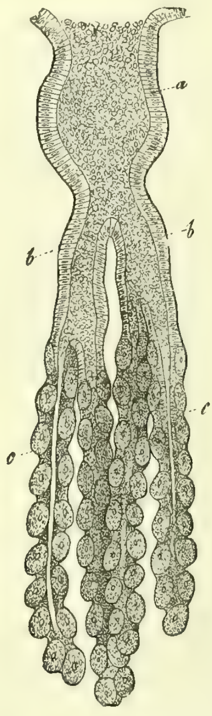


Fig. 702. Perpendicular section of the pyloric portion of the stomach of a pig. *a*, glands; *b*, muscular layer of the proper mucous membrane; *c*, submucous tissue with the orifices of divided vessels; *d*, transverse muscular layer; *e*, longitudinal ditto; *f*, serous coat. Magnified 30 diameters.

Fig. 703. Gastric gland with cylinder-epithelium, from the pylorus of a dog. *a*, principal cavity; *b*, tubular processes arising from it. Magnified 60 diameters.

Fig. 704. Gastric gland from the middle of the stomach. *a*, principal cavity; *b*, primary, and *c*, terminal branches arising from it. Magnified 60 diameters.

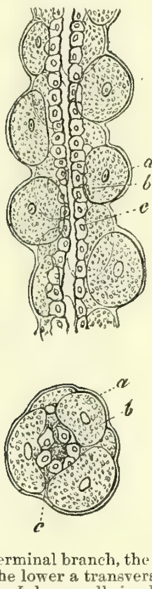
the gastric juice are tubular glands, perpendicularly placed beneath the surface of the mucous membrane, and extending as deeply as the muscular coat of the stomach.

They vary in length from 1-60 to 1-12″, are cylindrical, somewhat narrowed towards the closed end, which is rounded or somewhat inflated. The lower third is wavy or spiral, especially in the glands occupying the pylorus; some of them also give off a cæcal branch.

The gastric glands consist of a delicate basement membrane, lined in the upper third with cylindrical epithelium, the lower portion being filled with large, pale, polygonal, finely granular cells, not arranged in a laminated form.

In many animals the gastric glands are of more complicated structure than in man, and two distinct kinds exist—in one, secreting mucus, the tubes being lined with cylin-

Fig. 705.



Portions of a terminal branch, the upper representing a longitudinal, the lower a transverse section. *a*, basement membrane; *b*, large cells in close apposition with it; *c*, smaller epithelial cells surrounding the cavity. Magnified 350 diameters.

drical epithelium; whilst in the other, which secretes gastric juice, rounded epithelial cells occur, and the walls are expanded at intervals.

Closed follicles resembling the solitary glands of the small intestines are met with in the stomach; they are inconstant, however, and variable in number.

The stomach is lined by cylindrical epithelium.

Bibl. Kölliker, *Mikrosk. Anat.* ii. p. 137, and the Bibl. therein; Todd and Bowman, *Phys. Anat. &c.*; Brinton, *in Todd's Cycl. Anat. & Phys.* Art. *Stomach*; E. Klein *in Stricker's Hum. & Comp. Anat.* i. p. 343.

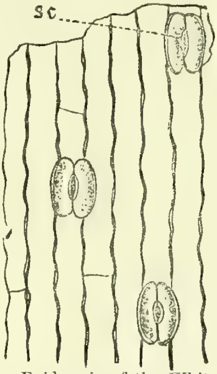
STOM'ATA (plural of Stoma).—This name is applied to the structures which constitute the passages of communication, through the Epidermis of plants, from the intercellular passages to the external air. They occur almost exclusively on the green parts of plants, and are absent from the epidermis of roots, also on the surface of all structures growing under water. The lowest classes which present them are the Liverworts and Mosses, where, however, they are limited to a few kinds, and in the former present a peculiar organization. In the Ferns they are distributed just as in the Flowering Plants, where they occur principally upon the leaves (fig. 706), especially upon the lower face, but extend also over the green shoots, the parts of the flower (fig. 200, page 284), and even into the interior of cavities, as on the epidermis of the *replum* of Cruciferæ (wallflower), and still more remarkably on the epidermis of seeds (skin of the walnut).

In the Liverworts the stomata occur on the fronds and receptacles of certain genera (*Marchantia, Fegatella,* &c. &c.). In *Marchantia* (fig. 447, p. 481), they are somewhat circular orifices in the epidermis, guarded by cells arranged in three or four tiers. In the Mosses they are met with on the apophyses or thickened summits of the setæ bearing the capsules, as in *Funaria* (fig. 262, page 329). The structures here resemble those in the higher plants, as is the case also with those on the leaves of Ferns.

In the Flowering Plants the perfect stomata appear as roundish or sometimes squarish chasms in the epidermal layer, occurring regularly at the meeting angles or sides of four or more epidermal cells, the chasm forming an orifice leading down to a subepidermal intercellular space, and guarded a little below the upper edge, more deeply, or even at the bottom, by (usually) two semilunar cells, applied together by their

flat faces, but not coherent, their convex surfaces adhering firmly to the sides of the epidermal gap. According as the two stomatal cells or "pore-cells" or "guard cells" are distended or collapsed, their flat faces approach or retreat from each other, in the latter case leaving a slit-like orifice leading from the outer passage into the subepidermal space. Sometimes the "guard cells" are four in number, in which case they either form two tiers, as upper and lower (Proteaceæ, *e. g. Hakea*, *Protea*, &c.), or they are in the same line and parallel, forming inner and outer "guard cells" (*Ficus elastica*). In certain coriaceous leaves the stomata are placed on the sides of pits excavated beneath the surface of the leaves, as in *Dasylirion longifolium* and *Nerium Oleander*.

Fig. 706.



Epidermis of the White Lily with stomata, *st* (lower surface).

Magnified 100 diameters.

A considerable difference exists between the appearances presented by vertical sections of the epidermis of leaves made so as to pass through the stomata. In young leaves the guard cells are little (if at all) below the general level of the epidermis; and the same is the case with the perfect forms of various herbaceous plants in which the leaves are of membranous texture. In other cases, as in the Hyacinth, *Iris*, *Narcissus*, *Equisetum*, &c., the guard cells are found at a very early period quite beneath the layer of epidermal cells, attached as it were *under* the passage communicating with the air. The same occurs very frequently in the stomata of coriaceous leaves, as in *Aloe* (Pl. 39. fig. 22), *Ficus*, *Cycas*, *Hakea*, *Protea*, &c. In other instances, also in leathery leaves, the "guard cells" appear more or less elevated *above* the general level of the epidermal cells, as in some species of *Leucadendron*, *Grevillea*, &c. It is important to observe that in the cases where the "guard cells" are sunk in the orifice of the epidermis, the upper margin of the orifice, formed by the borders of the surrounding epidermal cells, sometimes becomes elevated and even converted into a kind of perforated dome (Pl. 39. fig. 22) by development of the cuticular layers (see EPIDERMIS). This might be mistaken for the stoma itself. The same cuticular substance is often developed in mature leaves, not only down over the walls of the stomatal passage, but over the guard cells, and thence more or less into contiguous intercellular passages. This may be observed in *Euphorbia Caput-Medusæ*, *Helleborus niger* and *viridis*, *Betula alba*, *Asphodelus luteus*, and *Cereus*, some *Aloeæ*, &c. Gasparini obtained these connected processes of cuticular substance, in the form of an isolated coherent piece, by boiling epidermis in nitric acid, which dissolved the adjoining cell-walls: these he mistook for peculiar organs, and called them *cystomes*. Dr. Hooker has described a remarkable form of stomata in the parasitical plant *Myzodendron*.

In those plants in which the epidermis becomes infiltrated with siliceous matter, the walls of the stomatal pore and the "guard cells" become imbued with it, and a siliceous skeleton of the structure remains after the organic matter has been removed by nitric acid and burning (Pl. 39. fig. 29). This is readily seen in the Equisetaceæ, especially *E. hyemale*, also in the Grasses.

The mode of development of the stomata appears to be uncertain. Mohl and other authors assert that the "guard cells" originate from one of the cells of the subepidermal tissue, which is pushed up into a vacancy formed by the separation of the epidermal cells at certain points. This cell is said to be next divided into two, which become free from each other in the line of the new partition then formed. Nägeli and others assert that the guard cells are originally constituent cells of the epidermal layer, which become subsequently displaced downwards (or upwards), and undergo special development analogous to that just described. Dr. Garreau has described this mode of development as occurring in *Tradescantia*. We believe it is the correct view, at all events in some cases; but the appearances are certainly difficult to explain on this plan in the Iridaceæ, Equisetaceæ, and some other plants.

The stomata are generally largest upon succulent leaves, smallest on hard and leathery kinds; their form and number are most varied, both in different plants and on different parts of the same plant. They abound most on the lower face of leaves;

but it has been mentioned that they are not found on submerged organs, and on floating leaves they occur only upon the upper face. The larger kinds are more scattered on a given surface; the smaller occur closer together: this depends, of course, on the general character of the epidermal and subjacent tissue. The numbers have been estimated upon the surfaces of many leaves, of which a few examples may be given: thus a square inch contains, in the

	Upper surface.	Lower surface.
Carnation	38,500	38,500
Garden Flag	11,572	11,572
House-leek	10,710	6,000
Tradescantia	2,000	2,000
Mistletoe	200	200
Holly	0	63,600
Lilac	0	160,000
Vine	0	13,600
Laurestinus	0	90,000

BIBL. *General Works on Struct. Botany*; Mirbel, *Sur Marchantia, Mém. Acad. Roy. France*, xiii.; Gasparini, *Nuove ric. s. strutt. d. Cistomi*, Naples, 1844; Garreau, *Ann. des Sc. Nat.* 4 sér. i. p. 213; J. D. Hooker, *Flora Antarct.* i. p. 291; Golding Bird, *Proc. Linn. Society*, i. p. 290; Stocks, *MS.*; Biscoe, *Mo. Mic. Jn.* viii. p. 31.

STOMATA, ANIMAL. See LYMPHATIC SYSTEM and STAINING.

STONES OF FRUITS, such as cherries, plums, &c., afford excellent materials for sections, showing extreme development of the woody SECONDARY DEPOSITS of vegetable cells.

STRIA'RIA, Grev.—A genus of Dictyosiphonaceæ, nearly related to Punctariaceæ

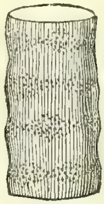
Fig. 707.

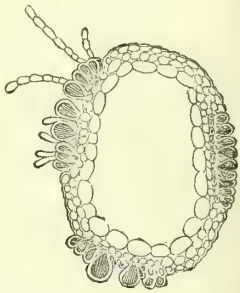
Striaria attenuata.

Fig. 707. Part of a frond. One-third of the nat. size.

(Fucoid Algæ), having a branched, filiform, tubular frond, arising from a shield-shaped naked disk. The walls of the tube are membranous, and the cavity without septa. *S. attenuata* (fig. 707) grows from 3 to 12″ high. The branches are attenuated towards each

Fig. 708. Fig. 709.





Striaria attenuata.

Fig. 708. A fragment with sori. Magnified 5 diams.
Fig. 709. Section of a fertile branch, with sori. Magnified 25 diameters.

end, and marked with rings consisting of clusters of simple sporanges ("spores") (fig. 708), sometimes accompanied by filaments (fig. 709). Colour pale olive.

BIBL. Harv. *Brit. Mar. Alg.* p. 41, pl. 8 A; Grev. *Brit. Alg.* fig. 9.

STRIATEL'LA, Ag.—A genus of Diatomaceæ.

Char. Frustules with a stipes attached to one angle, depressed, tabulate; with longitudinal uninterrupted vittæ, apparently thickened at each end. Marine.

The vittæ appear as dark lines; no transverse striæ are visible under ordinary illumination.

S. unipunctata (Pl. 13. fig. 20). Frustules in front view quadrangular, often broader than long, lateral margins subulate; valves narrowly lanceolate; stalk elongate, simple, filiform and thickish. Length of frustules 1-450 to 1-280″.

Compare the other genera enumerated under Striatelleæ (DIATOMACEÆ, p. 236).

BIBL. Kütz. *Bacill.* p. 125; *Spec. Alg.* p. 114; Rabenht. *Fl. Eur. Alg.* i. p. 307.

STRIG'ULA, Fries.—A genus of Limborieæ (Angiocarpous Lichens), containing one British species, *S. Babingtonii*, growing on the leaves of box and other evergreens. The thallus is subepidermal; the asci contain eight cymbiform triseptate spores.

BIBL. Leighton, *Brit. Angioc. Lich.* p. 70, pl. 30. fig. 4; Berk. *English Botany*, Supp. pl. 2957.

STROMBID'ION, Clap. et Lach.—A genus of HALTERINA (Infusoria).

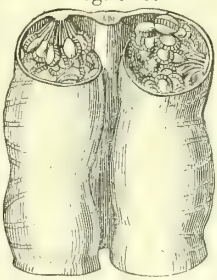
Char. No setæ for leaping, essentially swimmers.

BIBL. Claparède et Lachmann, *Etudes*, p. 371.

STRONTIA OR STRONTIAN.—The crystals of the sulphate of this earthy base are figured in Pl. 6. fig. 18, to contrast with those of the sulphates of baryta and lime.

STRUTHIOP'TERIS, Willden. — A genus of Polypodieæ (Ferns), with the margins of the fertile leaves rolled up so as to conceal the sori, which are without a true indusium. *Str. germanica* (fig. 710) is of large size; and the fertile fronds, distinct from the sterile, if cursorily examined, might lead to the reference of this plant to the Osmundeæ or "Flowering ferns."

Fig. 710.



Struthiopteris germanica. Portion of a pinna with the rolled margins covering the sori. Magnified 40 diameters.

STRYCHNINE, or STRYCHNIA. See ALKALOIDS, p. 30.

STYLOBIB'LIUM, Ehr.—A genus of fossil Diatomaceæ.

Char. Frustules circular, single, compound; valves contiguous, in a single row, like the leaves of a book, the inner ones with a large median aperture (?), the outer not being perforated but sculptured.

S. clypeus (Pl. 43. fig. 50 *a*, *b*); *S. divisum* (fig. 50 *c*); *S. eccentricum* (fig. 50 *d*). It is uncertain whether the so-called inner valves are merely hoops, or the valves of imperfectly separated frustules; also whether they are perforated or not, for neither Ehrenberg nor Kützing can be relied on for distinguishing a perforation, as evidenced by their erroneous description of the structure of the valves of *Pinnularia*, *Grammatophora*, and many other Diatomaceæ.

Three species are described, occurring in America and Siberia. The sculpturings upon the outer valves consist of radiating or excentric curved lines.

BIBL. Ehr. *Ber. d. Berl. Akad.* 1845; id. *Mikrogeologie, &c.*; Kütz. *Sp. Alg.* p. 116; Rabenht. *Fl. Eur. Alg.* i. p. 302.

STYLONICH'IA, Ehr.—A genus of Infusoria, of the family Oxytrichina.

Char. Body ciliated, and furnished with styles and hooks.

In this genus, transverse and longitudinal division, gemmation, and the encysting process have been observed.

S. mytilus=*Kerona mytilus*, D. (Pl. 24. figs. 27, 28). Body white, hyaline at each end, flat, oblong, slightly constricted in the middle, dilated at the oblique fore part. Aquatic; length 1-240 to 1-100″.

S. pustulata=*Kerona pustul.* D. (Pl. 24. fig. 26). Body white, turbid, oblong, with a median ventral band of hooks. Aquatic; length 1-144″.

S. histrio (Pl. 24. fig. 29). Body white, elliptic-oblong, hooks aggregated into an anterior heap; no setæ. Aquatic; length 1-290 to 1-220″; probably a variety of *S. pustulata*.

S. lanceolata (Pl. 24. fig. 30). Body lanceolate, pale green, obtuse at the ends; ventral surface flat; hooks acervate near the mouth; styles none. Aquatic; length 1-140 to 1-120″.

BIBL. Ehr. *Infus.* p. 370; Stein, *Infus.* p. 172; Pritchard, *Infus.* p. 643; Claparède et Lachmann, *Etudes*, p. 154.

STY'LOSPORES.—Stalked spores of Coniomycetous Fungi, usually compound or septate, then probably consisting of a row of independent spores connected by an adherent parent sac—thus, structurally, metamorphosed asci; they are sometimes appendaged above (fig. 711) (see SPORES and CONIOMYCETES).

Fig. 711.

Stylospores of Pestalozzia. Magnified 200 diameters.

SUCCINIC ACID.—This acid, which occurs in amber, in all fermented liquids, and in the contents of *Echinococcus*-cysts, is pretty soluble in water, readily in hot but with difficulty in cold alcohol, and but little in ether.

The crystals belong to the oblique prismatic system, and are represented in Pl. 7. fig. 21.

BIBL. That of CHEMISTRY.

SUDORIP'AROUS GLANDS.—These organs secrete the perspiration.

They are found in most parts of the skin, but in variable numbers in different localities. Thus it has been estimated that 417

exist in a square inch of the skin of the back of the hand, 1093 in an inch of the outside, and 1123 in the inside of the forearm, and 2736 in an inch of the palm of the hand.

Each gland consists of a long tube coiled into a knot near the closed end, which is situated in the subcutaneous cellular tissue, and forms the gland proper, and a straight, undulate, or spiral duct, which traverses the skin perpendicularly, to terminate upon its surface between the papillæ.

In the glands of the axilla, the portion of the tube forming the gland proper is branched; and sometimes the branches anastomose.

The coiled portion or proper gland is surrounded and permeated by an elegant plexus of capillaries; and some of them are surrounded by a capsule of areolar tissue with spindle-shaped cells.

The tube of the glands exhibits two forms of structure. In one of these there is an outer coat of indistinctly fibrous areolar tissue with elongated nuclei, sharply defined internally by probably a basement membrane, this being lined with one, two, or more layers of polygonal pavement-epithelial cells, mostly containing fat-globules and pigment-granules.

In the other form, the fibrillation of the areolar coat is tolerably distinct, the fibres longitudinal, sometimes also with an inner, delicate transverse layer, and both containing nuclear elastic fibres; and within this coat is a layer of longitudinal, unstriped muscular fibres.

The portion of the ducts traversing the cuticle is spiral.

It is by no means an easy matter to obtain the sudoriparous glands in the entire state. The skin of the palm of the hand or the paw of a dog is best for the purpose; and before making sections with a Valentin's knife, the structure should be macerated in a mixture of 1 part nitric acid and 2 of water, or in solution of carbonate of potash.

Fig. 712.

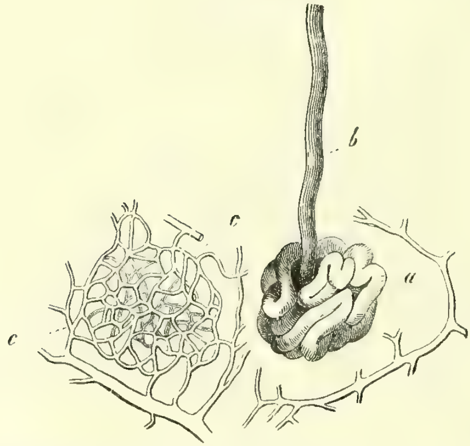


Fig. 713.

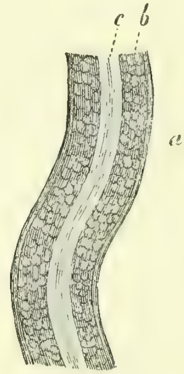
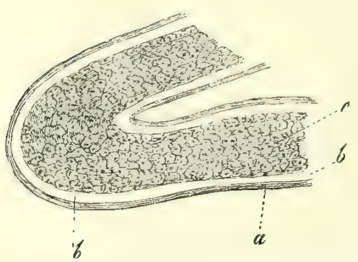


Fig. 712. A sudoriparous gland, with its blood-vessels. *a*, proper gland; *b*, duct; *c*, blood-vessels of a gland. Magnified 35 diameters

Fig. 713. Portion of the tube forming a sudoriparous gland from the hand. *a*, areolar coat; *b*, epithelium; *e*, cavity Magnified 350 diameters.

Fig. 714.



Portion of a tube with a muscular coat, from the scrotum. *a*, areolar tissue; *b*, muscular layer; *c*, epithelial cells, filling the tube and containing yellow granules.

Magnified 350 diameters.

Bibl. Kölliker, *Mikrosk. Anat.* ii.; Todd and Bowman, *Physiolog. Anat. &c.*; Biesiadecki, *in Stricker's Hum. & Comp. Hist.* ii. p. 238.

SUGAR.—This substance is liable to fraudulent adulterations; and the coarser kinds of brown sugar contain many impurities, such as Acari, fragments of the cane, &c. Starch and flour are used to whiten and give dryness to inferior moist sugar; and these may be detected by the microscope (Starch).

The crystals of sugar of milk are represented in Pl. 6. fig. 12, and those of diabetic sugar in Pl. 6. fig. 13.

Bibl. Hassall, *Food and its Adulterations*, p. 12, and the Bibl. of Chemistry.

SUPRARENAL CAPSULES or ADRENALS.—For general anatomy, see works on human and comparative anatomy, They are present in all the Vertebrate classes, and consist of two kinds of cellular structures, comprising the cortical and medullary substances. In mammals the two substances are arranged in a laminated manner. The external or cortical substance is greyish yellow or, if it contain much fat, whitish yellow in colour, and fractures in a radial direction. It invests the internal grey medullary masses in the form of a capsule, and penetrates this grey matter, here and there, being accompanied by large blood-vessels. No grey medullary matter exists in the thin marginal portions of the organ, but the innermost cortical layers here come into contact and form a simple brown stria.

Cortex. In the cortex either two or three distinct layers may be distinguished. In the latter case there is an external and also an internal layer of rounded cell-masses separated by a layer of cylindrical columns of cells; but where there are only two layers, as in the ox, horse, cat, rabbit, and mouse, the external cell-mass is wanting, and the cylindrical columns come into contact with the investing capsule of the organ. The cell-masses consist of polygonal and rounded balls of protoplasm, containing a single nucleus, and are either isolated or collected into groups; and the cylindrical columns consist of elongated cylindrical masses of cells. As they lie in successive rows, they give to thick sections of the cortex, when examined with low powers, the appearance of being composed of long parallel bands.

Medulla. Intervening between the plexus of large blood-vessels in the medulla is a spongy tissue composed of delicate connective tissue, in which lie the medullary cells. These are sometimes isolated, but are also frequently collected into rounded groups, as in man. The cells vary in form, and are very delicate in structure. In man they are stellate and polygonal; in the pig frequently columnar; in the horse and ox they are scarcely recognizable, a purely granular mass with centric or eccentric nuclei appearing in their stead, or columnar and stellate intercommunicating cells may be present in addition.

Stroma. The fibrous capsule of the organ gives off processes which penetrate into the interior, and separate off portions of the cortex and medulla. They give off fibres from their sides; and these merge into delicate columns of connective tissue, forming trabeculæ and including spaces filled with cell-growth.

Blood-vessels. The adrenals are exceedingly vascular. The arteries break up in the external cortical layer into a capillary plexus, the rounded meshes of which contain the cell-meshes already noticed. In the second or columnar layer they form short transverse anastomoses; and in the innermost layer the arrangement resembles that of the external. The vessels of the medulla are derived from the capillaries of the innermost cortical layer; they form a narrow meshed plexus of vessels varying in width, often presenting dilatations and discharging their contents into the veins. All these vessels are very thin-walled, their parietes being composed only of an endothelial tube. They lie in contact with the cell-masses, and are so firmly united with the sparingly intervening stroma as to be isolated with difficulty. Not much is known about the lymphatics; but the adrenals are rich in nerves, which divide in the medullary substance, where they form large decussating cords, and more rarely delicate plexuses. Bi- and multipolar ganglion-cells are frequently observable, partly isolated, partly forming large groups in the nerves of the medullary part. Ganglion-cells are rarely found in the cortex, and the nerves are fine and dark-edged.

Bibl. *Works on General and Comparative Anatomy*; Kölliker, *Handbuch*, 5. Aufl. 1867; Harley, *Lancet*, June, 1858; Eberth, *in Stricker's Hum. & Comp. Hist.* tr. Power. *Syd. Soc.* vii. p. 110.

SURIREL'LA, Turpin—A genus of Diatomaceæ.

Char. Frustules free, single, ovate, elliptical, oblong, cuneate or broadly linear in front view; valves with a longitudinal median line or a clear space, the margins winged, and with transverse or slightly radiating canaliculi or tubular striæ.

It appears that in the valves the margins of the depressions are fused together to form tubular channels open at the ends.

S. bifrons (Ehr. 1833=*S. biseriata*, Bréb. and Smith) (Pl. 13. fig. 22). Frustules in front view broadly linear, with rounded angles; valves elliptic-lanceolate, somewhat obtuse; alæ and canaliculi distinct. Aquatic; length 1-180 to 1-96″.

S. gemma (Pl. 13. fig. 21). Frustules ovate; valves elliptic-ovate; canaliculi narrow, inequidistant. Marine; length 1-240″.

Compare TRYBLIONELLA, and see DIATOMACEÆ.

BIBL. Smith, *Brit. Diatom.* i. p. 30; Kütz. *Bacill.* p. 59, and *Sp. Alg.* p. 34; Rabenht. *Fl. Eur. Alg.* i. p. 51; Pritchard, *Infusoria*, p. 794.

SWARMING.—This term has been applied, from comparison with the swarming of bees, to the remarkable oscillating crowding movements of the spores of Confervæ &c. while free in the cavity of the parent cell and preparing to break forth. The spores are hence often called "swarming-spores." See HYDRODICTYON.

SYMBOLOPH'ORA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, disk-shaped, with incomplete septa radiating from the solid angular centre, and intermediate bundles of radiating lines. Marine and fossil.

S. Trinitatis (Pl. 19. fig. 6). Valves with a triangular umbilicus, the transparent margins of which are crenulate, the rest of the disk covered with six bundles of very fine radiating lines. Diameter 1-220″. America.

S. acuta (Pl. 43. fig. 54); *S. micrasterias* (fig. 55); *S. pentas* (fig. 56).

BIBL. Ehr. *Ber. d. Berl. Akad.* 1844, p. 74; Kütz. *Sp. Alg.* p. 131; Pritchard, *Infus.* p. 833.

SYMPHYOSI'PHON, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), growing on the ground, &c. *S.* (*Scytonema*, Lyngb.) *Bangii* grows among mosses; it is of blackish colour, tufted and bristling, the filaments from 1-9600 to 1-7200″ in diameter.

BIBL. Kütz. *Sp. Alg.* p. 324; *Tab. Phyc.* ii. pl. 44. f. 1; Rabenht. *Fl. Eur. Alg.* ii. p. 278.

SYM'PLOCA, Kutz.—A genus of Oscillatoriaceæ (Confervoid Algæ), perhaps not distinct from *Symphyosiphon*.

SYNALIS'SA.—A genus of Collemaceæ (Gymnocarpous Lichens), somewhat resembling *Lichina*, but with open apothecia.

BIBL. Berk. *Crypt. Bot.* p. 407.

SYNA'PHIA, Perty=PEDIASTRUM.

SYNAP'TA, Eschsch.—A genus of vermiform Echinodermata, of the order Apoda.

The species of *Synapta*, which are not British, are of special microscopic interest, on account of the presence in their skin of remarkable anchor-shaped calcareous spicula, the bases of which play in perforated plates. These are situated upon minute papillæ of the skin, and serve to aid in locomotion and adhesion.

These bodies have been formed into genera and species of Polygastric Infusoria by Ehrenberg, the perforated plate constituting a *Dictyocha*.

BIBL. V. d. Hoeven, *Zoologie*, i. p. 150; Vogt, *Zool. Briefe*, i. p. 168; Quatrefages, *Ann. des Sc. Nat.* 2 sér. xvii. p. 19; Gegenbaur, *Vergleich. Anat.* p. 216; Carpenter, *The Microscope*, p. 566; Herapath, *Qu. Mic. Jn.* 1865, p. 1.

SYNCHÆ'TA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye single, cervical, rotatory organ furnished with styles; foot forked.

Jaws each with a single tooth.

Some of the species are furnished with one or more so-called crests, which in some appear to correspond to the calcar.

S. baltica (Pl. 35. fig. 26). Body ovate; rotatory lobes four; styles four; a single median sessile crest. Marine; length 1-108″. Phosphorescent.

BIBL. Ehr. *Infus.* p. 436; Pritchard, *Infus.* p. 685.

SYNCHIT'RIUM, De By. et Woronin.—A genus of parasitic Unicellular Algæ, allied to CHYTRIDIUM, found under the epidermis of the leaves of *Taraxacum*.

BIBL. Rabenht. *Fl. Eur. Alg.* iii. p. 284.

SYNCORY'NE, Ehr. (*pars*).—A genus of Corynidæ (Hydroida).

BIBL. Allman, *Ann. Nat. Hist.* May 1864; Hincks, *Brit. Hyd. Zooph.* p. 48.

SYNCRYP'TA, Ehr.—A doubtful genus of Volvocineæ (Confervoid Algæ), composed of organisms consisting of a hyaline spherical membrane ("gelatinous envelope," Ehr.) enclosing a number of ovate green bodies placed at the periphery and sending out a pair of free vibratile cilia (only *one*, Ehr.)

from the surface of the envelope. Green bodies not attenuated at the posterior extremity; "no eye-spot." *S. Volvox* (Pl. 3. fig. 14 *b*), globe 1-576" in diameter, green "animalcules" 1-2880" long; aquatic, not marine. This object, which we have observed in company with those represented in figs. 14 *a*, 31 and 32 of the same plate, is most probably a young specimen of either VOLVOX or PANDORINA.

BIBL. Ehr. *Infus.* p. 60; Pritchard, *Infus.* p. 519.

SYNCYC'LIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules cymbelliform, united in circular bands, immersed in an amorphous gelatinous substance. Marine.

The nodules appear to be the same as those of *Cymbella.*

S. salpa (Pl. 14. fig. 14). Frustules semiovate, unstriated (ord. illum.), commonly six together, united into a ring; endochrome bright green.

S. quaternaria. Frustules two or four together; endochrome yellow or reddish; length 1-860".

BIBL. Ehr. *Infus.* p. 233; *Ber. d. Berl. Akad.* 1840. 32; Kützing, *Sp. Alg.* 61; Rabenht. *Fl. Eur. Alg.* i. p. 97.

SYNDEN'DRIUM, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, subquadrangular, destitute of a median umbilicus; valves unequal, slightly turgid—one smooth, the other with numerous spines or little horns branched at the ends, situated upon the median flat portion, the margins being free from them.

S. diadema (Pl. 43. fig. 59). Frustules lanceolate; spines five or six, bifurcate or tufted at the end, as long as the frustules are broad. Breadth 1-1150". Found in Peruvian guano.

BIBL. Ehr. *Ber. d. Berl. Akad.* 1845, p. 155; Kütz. *Sp. Alg.* p. 141; Pritchard, *Infus.* p. 866.

SYNECHOCOC'CUS, Näg.—A genus of Unicellular Algæ.

Char. Cells oblong, either single or conjoined in series of 2–4. Cells dividing in one direction only; cytioplasm bronze-coloured or pale yellow.

S. æruginosus. Common on damp rocks and banks.

BIBL. Rabenht. *Fl. Eur. Alg.* ii. p. 59.

SYNE'DRA, Ehr.—A genus of Diatomaceæ.

Char. Frustules prismatic, rectangular, or curved; at first attached to a gelatinous sometimes lobed cushion, subsequently often becoming free; valves linear or lanceolate.

The valves usually exhibit a longitudinal line, with a dilated median and two terminal nodules; they are also generally covered with transverse striæ; in some species the median line and appearance of a median nodule correspond to a clear space, free from the transverse striæ.

Species very numerous.

S. splendens, K. (*S. radians*, Sm.) (Pl. 13. fig. 23 *a*, *b*, *c*). Frustules elongated, in front view dilated and truncate at the ends; valves gradually attenuated from the middle to the obtuse ends. Aquatic; common; length 1-70".

Frustules radiate upon the cushion.

S. fulgens (*Licmophora fulg.* K.) (Pl. 13. fig. 24). Frustules linear; valves slightly dilated in the middle and at the rounded ends, arranged in a fan-shaped manner upon the branched cushion. Marine; length 1-120".

S. capitata (Pl. 13. fig. 25). Frustules linear, truncate, ends slightly dilated; valves linear, ends dilated into a triangular head. Aquatic; length 1-60".

BIBL. Smith, *Brit. Diat.* i. p. 69; Kütz. *Sp. Alg.* p. 40; Rabenht. *Fl. Eur. Alg.* i. p. 126.

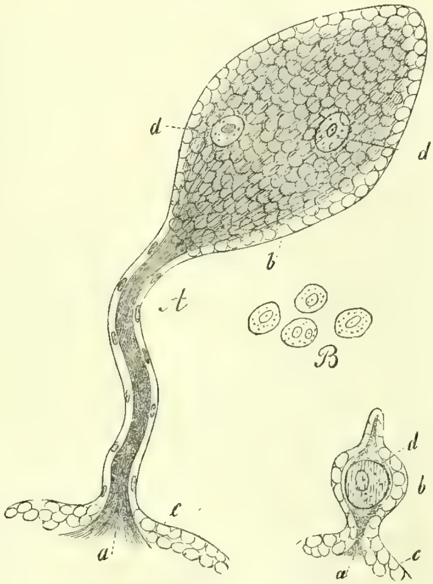
SYNOVIAL MEMBRANES.—In minute structure these resemble serous membranes; but their minute anatomy has by no means been satisfactorily determined. Brinton proved that the epithelium presents characters which distinguish synovial membranes from bursal and serous membranes. He remarked that it forms for the most part but one layer, the forms of the constituent cells of which vary to the same amount as those of the bursæ. The broad, squamous, polygonal epithelia are comparatively rare; and in by far the larger extent of its surface, the predominant shape is that of a slightly flattened spheroidal, oval, or sometimes angular cell, in some of which are seen decussations of two convex outlines, caused by the margin of one cell slightly overlapping that of its neighbour. They are firmly attached to the subjacent tissue, and possess little mutual adhesion. He showed that a stratum of loose cellular tissue was beneath these cells in the neighbourhood of ligaments, and that a basement membrane was not in existence. The same author, whose admirable work appears to have been most strangely neglected by the

German histologists, stated that over the cartilage of the articulation the vascular, fibrous, and epithelial structure of the synovial membrane covering the other parts of the joint are no longer seen. Where the synovial membrane reaches the border of articular cartilage, the arrangement is as follows:—The fibrous tissue exterior to the membrane, and with which its areolar tissue is mingled, passes to the side of the articular cartilage, and immediately becomes inextricably interlaced with its fibrous tissue or perichondrium. The plexus of capillaries, somewhat more tortuous here than on the plain surface, runs up to the edge of the cartilage, or may even advance a very short distance over it, where it is not exposed to friction during the movements of the joint. Its branches suddenly stop short, and each, taking a looped course, returns upon itself in the same tortuous manner. The layer of epithelium offers equally remarkable appearances; a few of its particles are very slightly flattened, but most of them are spherical and of various sizes, some being very large. All the larger contain a pale and rather flattened nucleus, which is in contact with a part of their inner surface. The cells are of singular delicacy and transparency, and are to all appearance distended with a fluid, the refractility and colour of which closely approximate to that of water. The areolar tissue, which forms the foundation of the membrane, being diverted at this point to join with the ligaments and perichondrium, the vessels are left comparatively naked, and the large cells are placed on these capillaries without the intervention of any membrane. This is also the arrangement on the edges and villi of the membranous expansions and folds of certain joints, such as the alar ligaments of the knee-joint. Brinton, after examining the opinions of Henle and Todd and Bowman concerning the continuity of the synovial membrane over the whole of the cartilage of joints, considered that the opinion of the first, which was to the effect that a tessellated epithelial membrane was continued over, and that of the second and third authors, which was in contradiction to this so far as adults were concerned, were capable of modification. In a specimen of diarthrodial cartilage taken from an adult mammal, if we make a thin section parallel to the articular surface, and look directly upon this part of the interior of the joint, the following are the appearances presented to view. A number of cartilage corpuscles at irregular distances from each other, and separated by the intercellular substance of this tissue, constitute the only cell-formation visible; and the existence of similar corpuscles at varying depths in the substance of the cartilage may easily be verified. The chief difference noticeable between the deeper and more superficial of these cells is, that those in the latter situation contain in their interior many yellow and highly refractile granules, which are of comparatively uniform size, and occupy their cavity about midway between their tolerably central nucleus and the inner surface of the cell-membrane. This appearance becomes still more manifest as the corpuscles approach the articular surface. A thin vertical section of the cartilage shows that the cells are in greater numbers near this surface; and the edge which borders the joint exhibits an irregular outline, from which cells may often be seen projecting. The attrition which these appearances would seem to denote appears to be exerted upon the cells equally with the interstitial substance of the cartilage, but is more difficult to verify in the former tissue, since such a cell that has suffered a partial destruction of its form has, at the same time, lost a valuable optical means of detection. Occasionally, however, on looking directly at the free surface of the tissue, we see a darkish nucleus lying very superficially, and surrounded by a clear space. In all probability this was such a cell ground down to a hemispherical cavity. More rarely a profile view of such a hemisphere is obtained. On examining similar specimens from animals of the same species at successively younger ages, the intercellular substance becomes gradually more scanty, and finally altogether disappears, leaving the whole of the surface occupied by a cell-growth which is a covering, but not an epithelium, unless we extend the application of this objectionable word and call the whole cartilage itself, what indeed we might with perfect truth, "a modified epithelium." The accuracy of this description of the cartilage of very young animals is easily verified by a vertical section; and if this be made sufficiently deep, it will include a portion of another structure, and a different process, with which it may be advantageous to compare it. At the furthest extremity of such a section we see the ossification of temporary cartilage actively

going forward. First comes the formation of cancelli and the enclosure of cells; next, a little nearer the articular surface, the greatly dilated cells are arranged in closely packed rows, the bottoms of which rest in cups of bone, which will soon become cancelli. Still approaching the articular surface, we find the cartilage corpuscles smaller, more refractile, and flatter; but yet with a distinctly linear arrangement. The loss of this arrangement in rows seems to indicate the limit of the ossifying cartilage, and the commencement of the articular lamina; and Brinton often saw the distinction still further marked out by a horizontal fissure in this situation—the effect of accidental violence, no doubt, but perhaps indicative of some deficiency of cohesion dependent on structure. Immediately beyond this situation the cartilage-cells are scattered irregularly, but closely, through the transparent intercellular substance. They are angular and refractile, and they contain a large granular nucleus. Many of them are elongated and somewhat spindle-shaped, while many more are triangular; and these two forms appear respectively to precede and follow a fissiparous multiplication of their numbers, the constancy and accuracy of which would almost allow of its being termed a bisection. From here onwards to the articular surface, the cells become more numerous, larger, and less angular in shape, until finally, on the surface itself, the increase of their number and size results in a continuous layer. But the appearances of this multiplication are not seen in the most superficial stratum of all, although the prevalence of the hemispherical outline still indicates the binary nature of the fission, whence it seems probable that just upon the surface the increase is one of bulk only.

Synovial membranes are sometimes furnished with appendages, some of which contain fatty tissue, others abound in capillaries and are met with forming fringes where the synovial membrane is attached to the articular cartilages. The latter consist of a basis of indistinctly fibrous areolar tissue, covered by the synovial epithelium, with a few fat-cells, sometimes isolated cartilage-cells, and the capillaries. Attached to their margins are flattened, conical, stalked, smaller appendages (fig. 715), seldom containing blood-vessels, and composed of indistinctly fibrous areolar tissue, with scattered cartilage-cells, and a thick epithelial layer; while some of the smaller ones consist almost entirely of epithelial cells or of areolar tissue.

Fig. 715.



From the synovial membrane of a finger-joint.

A. Two appendages of the synovial processes. *a*, areolar tissue in its axis; *b*, epithelium of the free margin; *c*, that continuous with the epithelium of the processes; *d*, cartilage-cells.

Magnified 250 diameters.

B. Four epithelial cells from the synovial membrane of the knee-joint, one of them with two nuclei.

Magnified 350 diameters.

BIBL. *General works on Anatomy and Physiology*; Brinton, *in Todd's Cycl. Anat. & Phys.* art. *Serous and Synovial Membranes*; E. Albert, *in Stricker's Hum. & Comp. Hist.* iii.

SYN'TETHYS, Forbes.—A genus of Tunicate Mollusca, of the family Botryllidæ.

Char. Mass sessile, gelatinous, forming a single system; animal sessile, having simple orifices, without rays. One species:

S. Hebridicus.

BIBL. Gosse, *Mar. Zool.* ii. p. 34.

SYNU'RA, Ehr.—A doubtful genus of Volvocineæ (Confervoid Algæ), described as consisting of a number of oblong corpuscles attached together by their prolonged filiform posterior extremities in the form of

a globe, the whole enclosed in a gelatinous sphere (or a membrane?); the corpuscles are said to have only one "flagelliform filament" (cilium), and no "eye-spot." In *S. Uvella* the corpuscles are yellowish, the "tails" three times as long as the bodies. Diameter of globes 1-290 to 1-190″. See VOLVOX.

BIBL. Ehr. *Infus.* p. 6; Pritchard, *Infus.* p. 519.

SYRINGID'IUM, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, terete; valves acuminate at one end, two-horned at the other. Marine.

S. bicorne (Pl. 43. figs. 32). Frustules oblong, smooth, not striated, turgid in the middle, one end attenuate, with two slight constrictions, and acuminate, the other subglobose, turgid, and with two horns. Length 1-370″. Coast of Africa.

S. palæmon (Pl. 43. fig. 33).

BIBL. Ehr. *Ber. d. Berl. Akad.* 1845, p. 365; Kütz. *Sp. Alg.* p. 32; Pritchard, *Infus.* p. 866.

SYSTEPHA'NIA, Ehr. — A genus of Diatomaceæ.

Char. Frustules circular; valves alike, areolar, neither radiate nor septate, with a crown of spines or an erect membrane on the outer surface of each valve (not on the margin). Fossil.

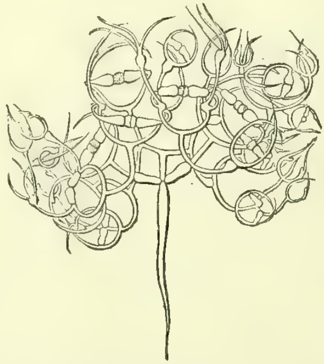
S. corona (Pl. 43. fig. 57); *S. diadema* (fig. 58).

One other species; found in Bermuda.

BIBL. Ehr. *Ber. d. Berl. Akad.* 1844, p. 264; Kütz. *Sp. Alg.* p. 126; Pritchard, *Infus.* p. 832.

SYZYGI'TES, Ehrenberg (see PHYCOMYCES).—A genus of Mucorini (Physomycetous Fungi), containing two species, a kind of mould growing over decaying Agarics, remarkable among all the class to which they belong for the occurrence of the phenomenon of conjugation of the branches as a preliminary to the formation of the spores. Ehrenberg discovered the conjugation in *S. megalocarpus* many years ago. The young filaments are simple, slender, rather rigid, pellucid and straight,—soon becoming forked, thickish, whitish yellow (somewhat olive when dry). The rudiments of the peridioles spring out as papillæ from the branches, becoming pear-shaped; and when two come into contact, they cohere, and become confluent into a fusiform body. The contents of the filaments next ascend and accumulate in the peridiole, at length forming a black globule (sporange?). While this is ripening, the apices grow out into long simple filaments.

Fig. 716.



Syzygites megalocarpus.
A branched filament, exhibiting the conjugation in various stages.
Magnified 200 diameters.

BIBL. Ehrenb. *Verhandl. Naturf. Freund.* Berlin, i. p. 91; Fries, *Syst. Myc.* iii. p. 329; Berkeley, *Ann. Nat. Hist.* i. p. 259; Van Tilgh, *Ann. d. Sci. Nat.* 873.

T.

TABELLARIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules tabular, attached, at first united into a filament, subsequently cohering only by the angles, with longitudinal vittæ interrupted in the middle; valves inflated in the middle and at each end, striated. Aquatic.

T. flocculosa (Pl. 13. fig. 27 *a*, *b*). Septa 3–5 on each margin. Length 1-960 to 1-840″.

T. fenestrata. Frustules oblong; vittæ two, opposite. Length 1-600 to 1-290″.

Five fossil species.

BIBL. Kütz. *Sp. Alg.* p. 118; Smith, *Brit. Diat.* ii. p. 44; Pritchard, *Infus.* p. 807.

TABLE.—A table for the conversion of foreign into English measures is given under MEASUREMENT (p. 486).

TACHYGO'NIUM, Näg.—A genus of Unicellular Algæ.

Char. Cells globose and cell-substance green, sometimes crowded with a red oleaginous substance; large vacuoles are often present; division takes place, and the for-

mation of groups of 4 to 8 gonidia, which may or may not be invested with a cell-wall. Fresh water. Friburg.

Bibl. Näg. *Beitr. z. wiss. Bot.* ii. p. 106; Rabenht. *Fl. Eur. Alg.* iii. p. 36.

TADPOLE. See Frog (p. 322).

TÆNIA (Tape-worm).—A genus of Entozoa, of the division Platelmia, order Tæniada of the Annuloida.

Char. Body elongate, compressed, jointed. Head mostly broader than the narrowed neck, with four suctorial depressions; and usually a median, imperforate, retractile rostellum, very frequently armed with one or two circles of minute recurved hooks, especially in the young state. Genital orifices situated at the margins of the joints or proglottides, either on one side only, or on both margins and on alternate joints.

The *Tæniæ*, of which the common tapeworm may be taken as the type, are found in vertebrate animals alone, and in these only in the alimentary canal. They are most common in birds, next in mammalia, then in fishes, and lastly in reptiles.

The species are very numerous.

Tænia solium, the common human English species, varies in breadth from 1-50 to 140″ at the anterior part, to about 1-3″ at the middle and posterior part. At the anterior extremity is situated a central rostellum, which is surrounded by a crown of small recurved hooks, as in Pl. 16. figs. 1 *f* & 10. Behind these are four suctorial depressions, which are not pervious at the bottom. The digestive system is wanting, and the worm absorbs by its superficies, but according to Blanchard, it is represented by two tubes or lateral canals (Pl. 16. fig. 14 *a*), having between them a transverse canal at the summit of each joint. These extend from the anterior to the posterior end of the body. In the cephalic portion, directly behind the suckers, there is a kind of lacuna or furrow communicating directly with these intestinal tubes; and it appears that the nutritive matters respired by means of the suckers penetrate into this lacuna, and thence into the digestive canals. These tubes have distinct walls, and are best seen when the animal has been macerated in water, and is examined by transmitted light, or after having been injected. All this is very doubtful.

The vascular system, according to the above author, consists of four longitudinal vessels (Pl. 16. fig. 14 *b*) situated a little above the intestinal tubes, and infinitely more slender. They traverse the whole length of the body; and between them are numerous transverse vessels (Pl. 16. fig. 14). The so-called digestive and vascular canals are one, and should be termed water-system; the canals unite in the last segment in a receptacle.

The male generative organ consists of a slender coiled tube, extending to near the principal ovigerous canal, where it is preceded by some very small testicular capsules (Pl. 16. fig. 14 *c*). The slender tube terminates in a duct (Pl. 16. fig. 14 *d*), which opens into the lateral orifice, or sometimes it projects externally in the form of a spiculum. The ovary consists of a principal median canal, presenting slight flexuosities, and extending nearly from one end to the other of each joint. It presents cæcal branches on both sides, and opens by a slender oviduct (Pl. 16. fig. 14 *e*) just within the genital orifice.

The ova are innumerable; one is figured in Pl. 16. fig. 15. They consist of an outer delicate membrane enclosing a gelatinous substance containing numerous highly refractive globules. Within this is another very delicate and transparent membrane, closely applied upon a brittle, dark-looking (by transmitted light, but white by reflected light), thick envelope, within which is the yolk or embryo, according to the state of development of the ovum. Very frequently the hooks of the young tænia are seen imbedded in its centre, as shown in the figure. The thick brittle coat of the ovum exhibits an appearance of radiating fibres (canals?); and when broken, the fractures are radiant. When the middle of the outer surface of the brittle envelope is brought into focus, it presents a tolerably regular appearance, as if composed of cells; this arises, however, from the extremities of the fibres being brought into focus.

The spermatozoa are readily found, simply by picking any joint containing ova to pieces with needles.

The young animal, consisting of head and neck only, was formerly considered distinct, and placed in a genus (*Scolex*).

For remarks on the development and other stages see Entozoa, and Cobbold, *Int. Parasites of Domestic Anim.* London, 1873; Perrier, *Archiv. de Zool. Expér.* ii. p. 349.

TÆNIOPTERIS, Hook.—A genus of Tænitideæ (Polypodioid Ferns). Exotic.

TÆNITIDEÆ.—A tribe of Polypodioid Ferns, without an indusium.

TALC. See MICA.

TAO'NIA, J. Ag.—A genus of Dictyotaceæ (Algæ), containing one rare British species, *T. atomaria*, which has a flat, membranous, fan-shaped, deeply cleft frond, 3 to 12″ high, of brownish olive colour; marked on both faces, at intervals of 1-4 to 1-2″, with concentric wavy lines, formed by rather crowded dark-brown "spores," the interspaces being dotted over with scattered spores. The disk of attachment is covered with woolly filaments.

BIBL. Harvey, *Brit. Mar. Alg.* p. 38, pl. 7 A; Thuret, *Ann. des Sc. Nat.* 4 sér. iii. p. 7.

TAPHROCAM'PA, Gosse.—A genus of Rotatoria, of the family Hydatinæa.

Char. Rotatory organs absent; body fusiform, annulose, tail forked, gizzard oval.

T. annulosa. Aquatic; length 1-110″.

BIBL. Gosse, *Ann. Nat. Hist.* 1851. viii. p. 199; Pritchard, *Infusoria*, p. 692.

TAPIOCA.—A very pure fecula prepared from the finer particles of the starch of the Mandioc or Cassava plant (Pl. 37. fig. 14). The starch-granules of tapioca of the shops appear to have undergone the action of heat, which disguises the characters. See STARCH.

TARDIG'RADA (Water-bears).—An order of Arachnida.

Char. See ARACHNIDA, p. 63.

These microscopic animals are found in stagnant fresh water, amongst water-plants, in patches of wet moss, in the gutters of houses, &c.

Body soft, cylindrical or elongate-oval in outline, with four transverse furrows or indistinct segments, and a fifth anterior, corresponding to a head, short, conical, retractile and with indications of two or three segments; sometimes dilated at the end to form a sucker, or furnished with unequal, short, palp-like processes. Eyes two.

The oral organs are represented by a tubular rostrum, through the sides of which, from without inwards, two calcareous styles or mandibles pass, and serve to wound the animals forming their prey. At the base of the rostrum is a gizzard with radiating muscular fibres, in *Macrobiotus* enclosing a kind of framework consisting of six parallel jointed cylinders.

The alimentary canal is straight, and furnished with lateral cæcal appendages. The ovary is a simple sac, behind which is situated a seminal vesicle containing spermatozoa, both opening into a cloaca. But few eggs are produced at a time; they are either smooth, rugose, or studded with points, and are usually deposited during the ecdysis, the exuviæ serving as a protection to them during the process of hatching. The young resemble the parents.

The Tardigrada resemble some of the Rotatoria in reviving after having been kept dried for years.

Genera: *Emydium, Macrobiotus, Milnesium* (*Arctiscon*, doubtful).

BIBL. Doyère, *Ann. des Sc. Nat.* 2 sér. xiv. 269, xvii. 193, xviii. 1; Dujardin, x. 185; Vogt, *Zoolog. Briefe*, i. 496; Kauffmann, *Siebold und Kölliker's Zeitschr.* iii. 220; Pritchard, *Infus.* p. 713; Greef, *Qu. Mic. Jn.* 1865, p. 220; Lubbock, *Metam. of Insects.*

TARGIO'NIA, Mich.—A genus of Pelliææ (Hepaticæ), characterized by the almost sessile globose capsule arising from the end of the midrib of the under face of the frond, which is somewhat fleshy, smooth, deep-green, purplish at the edges, and forms large patches on rather moist but exposed banks. The frond has an epidermis on both faces, with stomata and intermediate parenchyma; the midrib is only apparent beneath, and

Fig. 717.

Fig. 718.

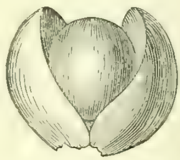


Fig. 719.

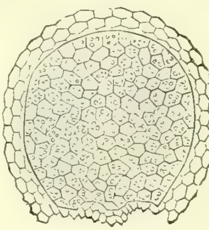


Fig. 720.

Targionia hypophylla.

Fig. 717. Lobe of a frond with fruit. Magnified 5 diameters.

Fig. 718. Perichæte opened, showing the globular sporange. Magnified 20 diameters.

Fig. 719. Vertical section of a very young sporange. Magnified 200 diameters

Fig. 720. A branched elater. Magnified 200 diameters.

has radical hairs, with purple scales. The perichæte originates from this rib, on the under surface, rising to the upper side (fig. 717). When mature, it is globose, of dark purplish colour and firm texture, and marked with a vertical prominent line or keel; at this line it ultimately splits into two valves (fig. 718). Hofmeister's recent observa-

Fig. 721.

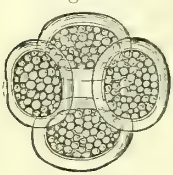


Fig. 722.

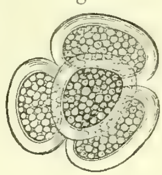


Fig. 723.

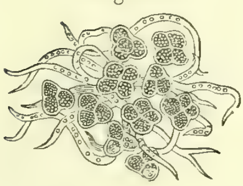
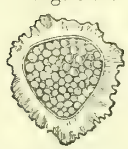


Fig. 724.

Fig. 725.



Figs. 721 & 722. Groups of four spores, not quite mature. Magnified 400 diameters.
Fig. 723. Parent cells of spores and imperfect elaters, from a more advanced fruit. Magnified 100 diameters.
Fig. 724. The same. Magnified 200 diameters.
Fig. 725. A single ripe spore. Magnified 400 diameters.

tions, however, show that this envelope grows up after the fertilization of the archegone, which is originally naked in its upper half; hence it would seem to be a *perigone*. Several archegones are found half-immersed in the end of the midrib; and one of these is converted into a fruit; the lower part becomes spherical, and the neck forms for a long time a filiform point or style. This epigone bursts irregularly and vertically. The spherical capsule emerges from it, but is not protruded beyond the perichæte. The globular capsule bursts irregularly at the summit, and discharges spores and elaters resembling those of *Marchantia* (figs. 723 to 725). The antheridia are imbedded in the midrib, opening on papillæ on the lower face.

Bibl. Hook. *Brit. Flor.* ii. pt. 2. p. 105; Corda, *Sturm's Deutschl. Fl. Jungerm.* pl. 36; Nees, *Lebermoose*, iv.

TARTARIC ACID.—The crystals of this substance, which belong to the oblique-prismatic system, exhibit beautiful colours under the polariscope. A concentrated aqueous solution is useful in the chloride-of-gold staining process.

TAXUS, L.—*Taxus baccata* is the Yew tree, belonging to the Coniferæ. Its wood (Pl. 39. fig. 4), as also that of *T. canadensis*, shows the remarkable combination of spiral fibres with the coniferous pits. Its embryology is also interesting. See Coniferæ and Ovule.

TEA (the prepared leaves of *Thea viridis* and *T. Bohea*, Nat. Ord. Ternstrœmiaceæ).—This important article of commerce has afforded some of the most remarkable examples of systematic fraud, practised not merely by the vendors in this country, but by the Chinese manufacturers. The principal adulterations of tea consist of remanufactured exhausted tea-leaves, spurious tea made up of the dust of tea and other leaves, together with earthy matter, by the aid of gum, and of spurious tea made of leaves of other plants,—the whole of these being prepared either for black or green tea by 'facing,' or imparting a colour or bloom with black-lead, indigo, prussian blue, mica, turmeric, &c.

The leaves of tea may be distinguished when moistened and spread out, and still more decidedly, even in fragments, by the aid of the microscope, which shows the peculiarities of the epidermis of the upper or lower faces. Other leaves fraudulently introduced may be thus separated, and often identified by careful comparison with known kinds likely to have been employed. The spurious tea made up of agglutinated rubbish falls to pieces instead of unrolling when infused with hot water. The 'facing' of the various kinds is mostly distinguishable with a common lens, and when the tea is infused forms a sediment, the characters of which may be determined by the microscope and by chemical analysis.

Bibl. Hassall, *Food and its Adulterations*, p. 268; Warington, *Trans. of Chemical Society of London*, 1851.

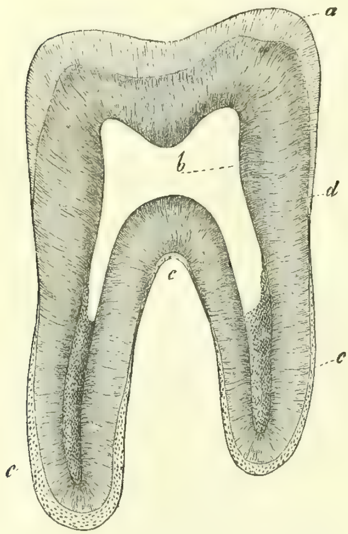
TEETH.—The teeth of the Mammalia are inserted in sockets or alveolar cavities of the jaws.

The teeth consist of:—a crown, or that portion which projects beyond the alveolar

cavity and the gum; the fangs, or the portions which are inserted into the bony structures; and a neck, or narrower intermediate portion. The crown of the tooth contains the pulp-cavity, which is closed above, but prolonged below through the fangs.

In regard to their structure, teeth are in

Fig. 726.



Molar tooth, human; longitudinal section.

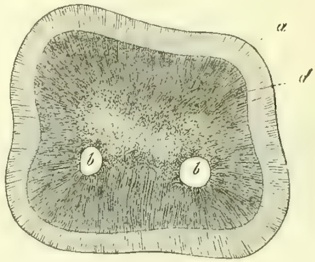
a, enamel; *b*, pulp-cavity; *c*, cement; *d*, ivory, with the ivory tube. Magnified 5 diameters.

part identical with bone, in part closely allied to it; but in respect to their development, they must be regarded as formations of the mucous membrane, as modified papillæ.

The substance of human teeth consists of three parts: the ivory or dentine (fig. 726 *d*), which constitutes the greater portion of their mass, and to which their form is mainly owing; the cement, or bony portion (fig. 726 *c*), which forms an external covering, principally of the fangs; and the enamel (fig. 726 *a*), which covers the crown.

The *ivory* or *dentine* (figs. 726 *d*, 727 *d*) is whitish and of a silky lustre, and, excepting a small portion at the base of the fangs, forms the entire boundary of the cavity of the teeth. It consists of a homogeneous matrix analogous to compact bony tissue, enveloping numerous tubes or canaliculi, called the 'ivory-tubes' (fig. 729 *a*, *b*), in which are dentinal fibres. The tubes are very fine, and pursue an undulating course, at first curving, then bifurcating, throughout

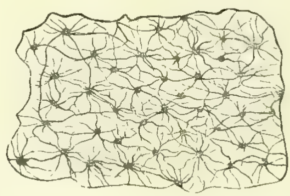
Fig. 727.



Transverse section of the same; the references as above. Magnified 5 diameters.

giving off numerous fine lateral communicating branches, which are best seen in a horizontal section (fig. 728), and ultimately ramifying and anastomosing freely. They commence at the surface of the pulp-cavity, in the crown following a somewhat radiating direction from its centre (fig. 726), whilst in the fangs their course is more hori-

Fig. 728.



Transverse section of the ivory-tubes of the fang (*a*, fig. 729), showing their numerous anastomoses.

Magnified 450 diameters.

zontal. They have distinct walls (the dentinal sheaths) about equal in thickness to their calibre—although in transverse sections (fig. 730) this thickness is generally exaggerated, on account of their being obliquely divided. They contain air in the dry state, which may be displaced by liquids. By removing the inorganic salts from a tooth with dilute muriatic acid, and maceratiag the remaining cartilage with acids or caustic alkalies until it forms a pasty mass, the tubes may be isolated from the basis.

In sections made from fresh teeth, high powers of the microscope (500 or 1000

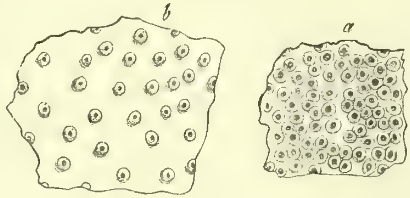
linear) being used, it is not difficult to recognize, especially in the centre of the tooth,

Fig. 729.

Ivory-tubes of a fang of a human tooth. *a*, inner surface of the ivory, with few tubes; *b*, their branches; *c*, their terminations in loops; *d*, granular layer, consisting of small ivory globules at the boundary of the ivory; *e*, lacunæ of bone, one anastomosing with an ivory-tube. Magnified 350 diameters.

the fine, pale, homogeneous, non-nucleated, extensile, dentinal fibres. The dentinal sheaths or lining of the tubes can only be seen satisfactorily in cross sections, when they appear as delicate yellowish rings. The

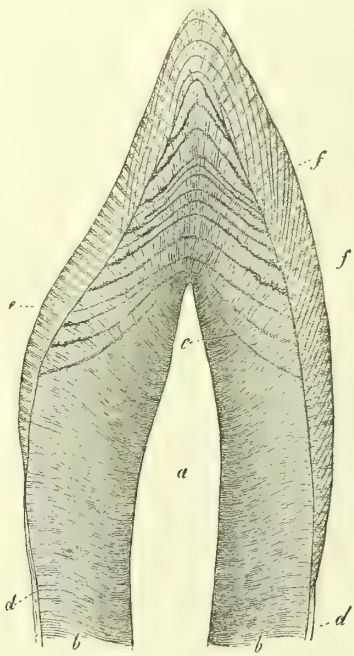
Fig. 730.



Transverse section of the ivory-tubes. *a*, closely aggregated; *b*, wider apart. Magnified 450 diameters.

dentinal fibres stain with carmine; and Salter considers them to be hollow; but on

Fig. 731.



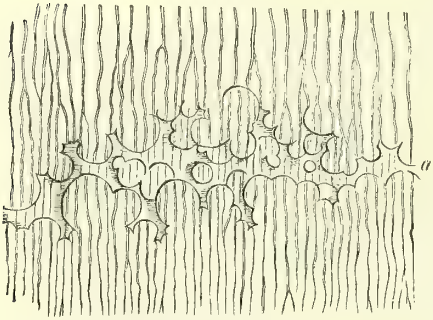
Perpendicular section of the apex of a human incisor tooth. *a*, pulp-cavity; *b*, ivory; *c*, curved contour lines with interglobular spaces; *d*, cement; *e*, enamel, with indications of the course of the fibres in various directions; *f*, coloured stripes of the enamel.

Magnified 7 diameters.

this point there is a difference of opinion, Waldeyer discrediting this statement.

The ivory not unfrequently exhibits indications of a laminated structure, forming,

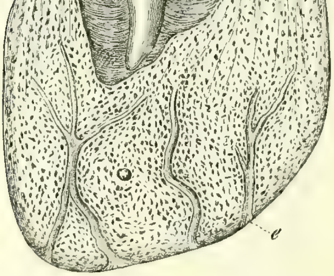
Fig. 732.



Portion of the ivory, with ivory globules and interglobular spaces filled with air. Magnified 350 diams.

in longitudinal sections, curved lines more or less parallel to the outline of the crown (fig. 731), appearing as rings in transverse sections, and called the *contour-lines.*

Fig. 733.



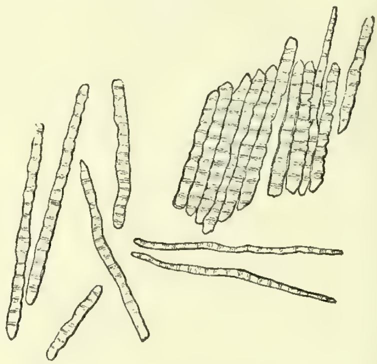
Cement and ivory of the fang of a tooth of an old person. *a*, cavity; *b*, ivory; *c*, cement with lacunæ; *e*, Haversian canals. Magnified 30 diameters.

Near the enamel (fig. 731) and the cement (fig. 729 *d*) also, the ivory presents one or more irregular dark patches or bands, often continuous with the ends of the contour-lines, and exhibiting a coarsely cellular appearance. On careful examination, the dark appearance is seen to result from a number of irregular spaces filled with air (fig. 732 *a*) intervening between certain globules, called *ivory-globules,* the spaces being termed the *interglobular spaces.* In the recent tooth, these spaces are filled with the organic basis of the ivory, containing tubes like the rest of that substance, in which, however, the inorganic matter has not been deposited; hence this structure arises from imperfect development.

Other, ill-defined iridescent stripes, running parallel to the pulp-cavity, are sometimes seen; these correspond to the primary curves of the ivory-tubes.

The *cement* or bone of teeth forms the outer coating of the fangs (*c*, figs. 726 & 733),

Fig. 734.



Enamel-fibres, isolated by the very slight action of muriatic acid; human. Magnified 350 diameters.

sometimes cementing them together. It commences as a very thin layer at the part where the enamel ceases, increasing in thickness towards the ends of the fangs. The cement does not differ from bone in structure, except in rarely containing Haversian canals. In the molar teeth of old persons, however, these are met with (fig. 733 *e*). The lacunæ are frequently absent from the thinner portion of the cement; and it sometimes contains tubes like those of the ivory. The interlacunar substance is sometimes striated, and exhibits a laminated structure.

The *enamel* (fig. 726 *a*) covers the ivory

of the crown of the teeth. It is thickest at the opposing surface, decreasing towards the neck, where it terminates. The *cuticula* is an extremely resistant investment to the exposed portions of the teeth, and which disappears when they are mature. It is separable after the action of muriatic acid, and may be tinted with a solution of nitrate of silver, which causes the appearance of figures like large epithelial cells. The enamel has a fibrous aspect, and appears of a bluish-white colour by reflected light, and of a greyish brown by transmitted light. It is very brittle, and so hard as to strike fire with steel. It consists of numerous solid fibres or prisms (fig. 734), about 1-6000 to 1-5000″ in breadth, mostly six-sided, more or less wavy, slightly varicose, and transversely striped. These usually extend throughout the thickness of the enamel, and are placed in a direction generally perpendicular to the surface of the portions of the ivory which they cover (figs. 726, 731). The form of the fibres is best seen by viewing their ends or a transverse section (fig. 735). The prisms do not

Fig. 735.

Fig. 736.

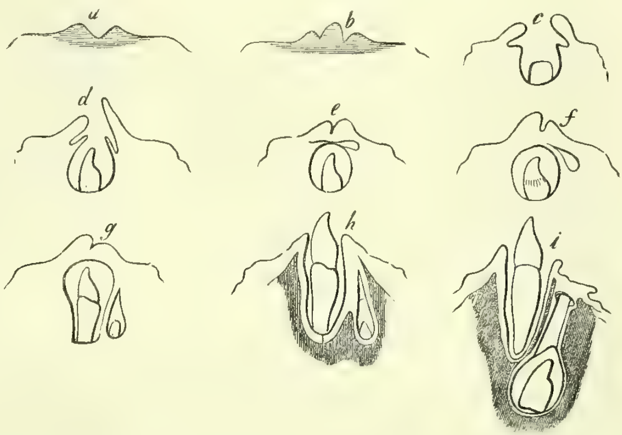


Fig. 735. Surface of the enamel, with the ends of the enamel-fibres, from the tooth of a calf. Magnified 350 diameters.

Fig. 736. Diagram showing the development of a milk-tooth, and the corresponding permanent tooth. *a*, furrow *b*, the same with the papilla; *c*, the same closing, with the commencement of the reserve cavity; *d*, the same, further closing; *e*, follicle completely formed, with the reserve cavity; *f*, the reserve cavity receding; *g*, the same, with a tooth-germ; *h*, the alveoli of both capsules formed, the milk-tooth being through the gum; *i*, the same further advanced, the neck of the capsule forming a solid cord.

run exactly parallel with each other, but are arranged in groups or zones, the fibres of which cross each other. The fibres are readily isolated before they have become so developed as to be hard, and when very slightly acted upon by muriatic acid. It is doubtful if sometimes the ivory-tubes extend into the enamel.

Two kinds of dark bands or stripes are seen traversing the enamel (fig. 731). The direction of one of these coincides pretty nearly with that of the fibres, and it arises from the crossing of the zones of fibres, allowing more or less light to pass through, the bands being light and dark. The other set (fig. 731 *ff*) consists of arched, brownish stripes, indicating the laminated structure of the enamel. Under the polariscope, a third set becomes visible, arising from the variable inclination of the axes of the fibres to the plane of polarization.

The enamel is often traversed by cracks, mostly running parallel with the fibres, and containing air in dry teeth.

Soft structures.—The soft structures belonging to the teeth are those of the pulp, which is the vascular and nervous matrix of the dentine and the remains of the original tooth papilla. The pulp is reduced to a very slender thread in the human tooth; and it contains a few blood-vessels and nerves, being connected with the periosteum and base of the socket of the jaw. The principal part is made of indistinctly fibrous

connective tissue, containing numerous cells; and it appears to be quite cavernous from the breaking up of the terminal capillaries. The external layer is formed of large cells of elongated form, and provided with numerous processes called odontoblasts, which are arranged so as to form a kind of columnar epithelium. They are finely granular, but have no cell-wall. Three kinds of processes may be distinguished in these cells—the dentinal, pulp, and lateral processes. The dentinal processes become the before-mentioned dentinal fibres of the ivory.

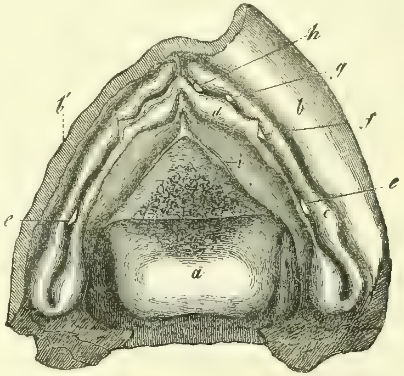
Very little is known respecting the distribution and termination of the nerves of the teeth.

Chemically, teeth consist of an organic, cartilaginous basis, agreeing in composition with that of bone, and of inorganic matter, consisting principally of phosphate of lime with a small quantity of the carbonate.

Development.—The rudiments or germs of the first (milk) teeth are met with in the sixth week of fœtal life, and consist of small papillæ, one for each tooth, which become visible in grooves of the mouth, afterwards forming the alveolar processes. The margins of the jaw at the beginning of the third month form a slight ridge, which consists of a thickening of the embryonic connective tissue and epithelium of the mucous membrane of the mouth. The epithelium forms the enamel, and the other tissue the dentine and cement. Processes from the sides of these dental grooves are then formed, and, approaching each other, enclose the papillæ in distinct follicles, the margins of which gradually grow over the papillæ, and uniting, convert them into closed sacs or capsules. The pulps then become moulded into the form of the future teeth, the bases of the pulps dividing into as many portions as the teeth have fangs; and as the capsules increase at this stage faster than the pulps, a space is left between them, in which a gelatinous-looking substance is deposited from the wall of the capsule forming the enamel-organ.

The capsule (fig. 738 *a*) possesses an areolar coat with vessels and nerves; and from its base arises the tooth-germ or pulp (fig. 738 *h*). The pulp consists of an outer non-vascular layer of elongated nucleated cells, with filiform processes, in close apposition (fig. 739 *a*), covering the surface of the pulp—the ivory-membrane (fig. 738 *f*) not distinctly defined internally, but gradually passing into the vascular parenchyma of the pulp. The inner part of the pulp consists of indistinctly fibrous areolar tissue with nuclei, the vessels terminating in loops beneath the enamel-membrane (fig. 739 *c*).

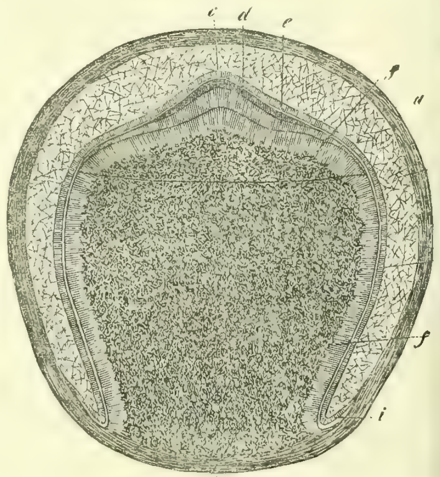
Fig. 737.



Lower jaw of a human nine weeks' fœtus. *a*, tongue, turned back; *b*, right half of the lower lip turned aside; *b'*, left half of the lip cut off; *c*, outer wall of the gum; *d*, inner wall of the gum; *e*, *f*, *g*, *h*, papillæ of the teeth; *i*, fold where the sublingual duct subsequently opens.

Magnified 9 diameters

Fig. 738.



Capsule of the second incisor tooth of an eight months' human fœtus. *a*, capsule; *b*, enamel-pulp; *c*, enamel-membrane; *d*, enamel; *f*, ivory cells; *h*, papilla of tooth or pulp; *i*, free margin of enamel-organ.

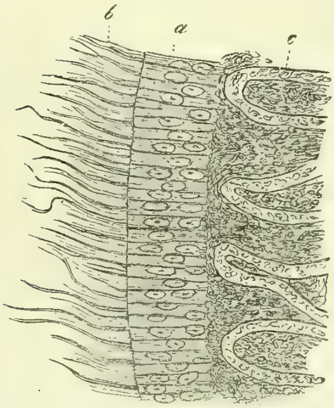
Magnified 30 diameters.

The enamel-organ (fig. 738 *b*) covers by its inner concave surface the pulp, its out-

side being in apposition with the capsule. It forms a spongy tissue, composed of anastomosing stellate cells or reticular areolar tissue; in its inside is the enamel-membrane, consisting of cylindrical epithelium (fig. 738 *c*).

The enamel is formed by the direct cal-

Fig. 739.



Surface of the pulp of a newly-born infant. *a*, ivory-cells; *b*, their appendages; *c*, vascular part of the pulp. Magnified 300 diameters.

cification of the epithelium, the prisms resulting from the calcification of the long cylindrical cells. The delicate membrane described by Huxley in his account of the structure of the teeth, and which can be raised with tolerable facility from the surface of the developing enamel after it has been subjected to the action of hydrochloric acid, is probably the youngest layer of the enamel, as yet but slightly impregnated with mineral matter.

Ossification commences by the deposition of calcareous matter in the cells of the ivory membrane at the summit of the pulp; this is soon followed by similar deposition in the cells of the enamel-membrane. By the further formation of new cells and fresh deposition, the structure of the teeth becomes more and more consolidated, the spongy tissue of the enamel gradually being absorbed.

When the entire enamel and a considerable portion of the ivory have been formed in the capsules, these become too small to contain the teeth, which then rupture them, and continue to grow at the root, until the crown projects above the margin of the jaw. The remainder of the capsule then forms the periosteum of the alveoli, and, by deposition from the side next the tooth, produces the cement.

The permanent teeth are formed upon the same plan:—the three last molars in the remains of the primitive dental groove; the others in distinct sacs, called reserve sacs, and formed in the wall of the follicles of the milk-teeth.

The teeth of animals present numerous interesting varieties, to which we can but briefly refer. Thus, in the Mammalia the enamel is often absent, the cement frequently extends over the crown, the three component structures are folded, the teeth are compound, the ivory contains Haversian canals, and the ivory-tubes enter the enamel. In Reptiles the teeth are often anchylosed to the jaws. In Fishes the teeth are often solid; the ivory is furnished with Haversian canals, sometimes isolated, and each surrounded by a layer of ivory and cement, so that the teeth appear to consist of aggregations of little teeth; the vessels often branch and anastomose freely; the ivory tubes are often very large or absent, the ivory then consisting of a finely granular base with numerous vascular canals, true enamel appearing to be absent.

The oral and gastric teeth of the Mollusca (see Tongue), Vermes, and Arthropoda, are composed of chitine, which is sometimes impregnated with lime or silica. The teeth of Echinida are composed essentially of thin leaflets aggregated into a radial lamina; and they are composed of elongated prisms of carbonate of lime, somewhat curved at their extremities. These lustrous calcareous plates lie between the prisms, and present a fine plexus of anastomosing canaliculi.

It may be said generally that the teeth amongst the higher Invertebrata are to be regarded as epithelial structures, and that in the lowest Vertebrata they are chiefly composed of peculiarly modified and ossified connective tissue. In the higher Vertebrata the teeth are again epithelial structures, and enamel is present in most.

The method of making sections of teeth is described under Preparation. They should be very thin, and preserved in the dry state.

Bibl. Owen, *Odontography*, and *Todd's Cycl. Anat. &c.* iv. 864; Goodsir, *Edinb. Med. and Surg. Journ.* 1839, i.; Tomes, *Lectures on Dental Surgery, &c.*, and *Phil. Trans.* 1849, 1850; Nasmyth, *Researches on the Teeth*; Retzius, *Müller's Archiv*, 1837,

p. 486; Hanover, *Verh. d. Leopold. Carol. Akad.* xxv. p. 2 (*Micr. Journ.* 1857, v. p. 166); Huxley, *Qu. Mic. Jn.* 1854, 1855, 1857; Ray Lankester, *Qu. Mic. Jn.* 1867; Boll, *Untersuch. ü. d. Zahnpulpa, Arch. f. Mik. Anat.* iv. 1868; Cutler *in Dental Cosmos,* 1867; Rolleston, *Qu. Mic. Jn.* 1872; Waldeger *in Stricker's Hum. & Comp. Hist.* i.; White, *Mo. Mic. Jn.* vii. p. 263.

TEM'ORA, Baird.—A genus of Entomostraca, of the order Copepoda, and family Diaptomidæ.

Char. Thorax composed of five, abdomen of three joints; lesser antennæ two-branched; first four pairs of legs each giving off a two-jointed branch.

T. finmarchica. Found on the coast of Ireland.

Bibl. Baird, *Brit. Entomostr.* p. 227.

TENDON. See Ligaments.

TENTHRE'DO, Leach.—A genus of Hymenopterous Insects, of the order Tenthredinidæ (Saw-flies).

The species of *Tenthredo* and of the other genera belonging to the family, both of which are very numerous, are interesting on account of the remarkable structure of the ovipositor, which consists of two flattened and curved saw-like plates. These are used to saw the leaves of plants, for the deposition of the eggs.

The insects are found upon gooseberry-bushes, rose-bushes, the white thorn, the willow, alder, poplar, the plum- and other fruit-trees, cabbage, turnip, bramble, &c. The larvæ are very destructive to agricultural crops.

T. nassata is represented in figure 363 (p. 425).

Bibl. Westwood, *Introduction, &c.* ii. p. 90, and the *Bibl.* therein.

TEREBEL'LA.—A genus of Tubicolar Annelida.

The animal forms a tube out of sand and portions of shell, which are agglutinated by a secretion. Dr. Carpenter remarks that the respiratory organs situated in the part outside the tube—the head—may be examined with very satisfactory results by the microscopist. Two fluids may be seen circulating:—1. a colourless fluid containing numerous cell-like corpuscles, which can be seen in the smaller and more transparent species to occupy the space that intervenes between the outer surface of the alimentary canal and inner wall of the body and to pass from this into canals, which often ramify extensively in the respiratory organs, but are never furnished with a returning series of passages; 2. a fluid which is usually red and contains a few particles, and is enclosed in a system of proper vessels that communicate with a central propelling organ. In *Terebella* a distinct provision is made for the aëration of both fluids; for the first is transmitted to the tendril-like tentacula which surround the mouth, whilst the second circulates through the beautiful arborescent branchiæ situated just behind the head. The former are covered with cilia, the action of which continually renews the water in contact with them, whilst the latter are destitute of them. The colourless fluid is probably blood, and the red fluid belongs to the water system.

Bibl. Huxley, *Elem. Comp. Anat.*; Carpenter, *The Microscope.*

TERPSIN'OE, Ehr.—A genus of Diatomaceæ.

Char. Frustules tabular, obsoletely stalked, subsequently connected by isthmi, and with transverse, short, interrupted, capitate vittæ; valves in side view with lateral inflations.

T. musica (Pl. 14. fig. 33, side view; Pl. 19. fig. 10, front view). Frustules very faintly punctate, in front view rectangular oblong; side view equally inflated in the middle and at the ends, in older specimens constricted in the middle, inflated beyond the middle towards both ends, the apices produced and obtuse, the nodules separated by septa. Length 1-180″.

T. indica (*Anaulus ind.*, E.).

Bibl. Ehr. *Abhand. d. Berl. Akad.* 1841, p. 402; Kütz. *Bacill.* p. 128; *Sp. Alg.* p. 119; Pritchard, *Infus.* p. 850.

TESSEL'LA, Ehr.—A genus of Diatomaceæ.

Char. Frustules broadly tabular, not concatenate, with crowded, longitudinal, alternate vittæ, interrupted in the middle; stipes absent (?). Marine.

T. interrupta (Pl. 14. fig. 35). Length of frustules 1-580; breadth 1-560 to 1-120″. Found with *Striatella.*

Bibl. Ehr. *Infus.* p. 202; Kütz. *Bacill.* p. 125; *Sp. Alg.* p. 114; Pritchard, *Infus.* p. 804.

TES'TES.—The general and comparative anatomy of the male organs of generation is given in standard works of human and comparative anatomy. It is only necessary to notice the histology of the tubuli seminiferi, or the proper gland substance of the testicle. Their average diameter is

0·2 millim.; and the thickness of their tubular wall varies with the degree of distension. They commence by simple closed extremities, and often anastomose. The membrane of the tubule appears to be both longitudinally and concentrically striated; and there are dark rod-shaped nuclei between the striæ. It presents a homogeneous appearance when spread out and examined from the surface, and has tolerably regularly arranged and very pale circular nuclei. It may therefore be considered to possess a lamellar structure, and to be composed of flat scales with flattened nuclei. The long tubules, thus composed of a simple external membrane, are united more or less by an interstitial connective tissue, in which a peculiar cellulo-granular structure accompanies the blood-vessels, and is especially visible in the Boar, Horse, and Lizard.

The contents of the tubules consist of cells, the external layer of which has been termed the epithelium; and on these are placed the seminal cells.

Epithelial cells.—The contents of the tubules evidently frequently exhibit a radial structure; and the cells constituting the peripheral layer have a peculiar form. But our knowledge of their peculiarities depends upon our correct appreciation of the action of such reagents as Sol. Hyd. Bichlor. (0·5 per cent.), solution of caustic potash, and chromic-acid solution ($\frac{1}{4}$ per cent.). Probably these cells of irregular aspect consist of masses of reticulated protoplasm with nuclei.

Seminal cells.—Two principal types may be distinguished—one with dark granular nuclei, and the other with clear nuclei with or without nucleoli. The number of the nuclei varies, and cells may have one or two or many more. The cells are globular; and many are to be seen undergoing proliferation, budding cells and chains of cells being common. Fissiparous division through the nucleus occurs also, especially in young animals. Moreover all these cells have amœboid movements. Besides these cellular elements, which line or fill the interior of the tubuli, there are the spermatozoa. The general shape of these has been described. (See SPERMATOZOA.) They are developed from the single or multi- granulo-nucleated cells just mentioned. Each nucleus becomes the so-called body or head of the spermatozoon, and the protoplasm of the cell develops the cilium or tail; and the cell-wall, through which the altered nucleus projects, is gradually absorbed. In some instances the large head is gradually absorbed, but probably never entirely so.

BIBL. *General works on Anatomy and Physiology, &c.*; Valette St. George *in Stricker's Hum. & Comp. Hist.* and the *Bibl.* therein, ii. p. 131 (tr. Power).

TEST-OBJECTS. — Test-objects are microscopic objects used to determine the value of object-glasses.

We must presume that the reader has perused the remarks upon object-glasses in the INTRODUCTION (p. xiv), also the article ANGULAR APERTURE; otherwise the observations made here will be unintelligible.

The main points in which object-glasses differ from each other are four: viz. (1) their magnifying power; (2) their defining power; (3) their penetrating power; and (4) their corrective adaptations.

1. The magnifying or separating power scarcely requires notice; it must be adapted to the size of the objects likely to come under examination. Usually, several object-glasses are kept, of different powers; at all events, if scientific investigations are to be pursued, a power of 400 diameters must be accessible, and this without the use of the highest eyepiece. The magnifying power should be ascertained by MEASUREMENT, and not by judging from the focal length.

2. Good defining power is the most important character of an object-glass; and if good in respect to this, the dark boundary lines of the test-objects will appear clear, black, sharp, as if engraved, and quite free from colour. If this is ascertained to be the case, the higher eyepieces should be put on; and it must be observed that although the sharpness of the outline is somewhat diminished, all the parts are clearly distinguishable as before. In this examination the light should be as direct as possible.

3. The power of displaying the minute structural peculiarities of objects, or the penetrating power, as it is called, depends upon two distinct circumstances—the goodness of the defining power, and the magnitude of the angular aperture of the object-glass: the degree of obliquity of the light is also of great importance in connexion with the latter.

Thus, in examining the scale of a *Podura* (Pl. 1. fig. 12 *a*, *b*, *c*), the magnifying power being sufficiently high, if the defining power be good, the wedge-shaped bodies will be clearly and sharply displayed by direct light,

and whether the angular aperture be large or small. Now, if we examine a valve of *Gyrosigma* (Pl. 1. figs. 17 & 18) by direct light, the minute structure will be invisible, however small or large the angular aperture may be, or however perfect the defining power; but if the light be thrown obliquely, and the aperture be sufficient, the striæ will at once become evident. Hence there are two distinct kinds of penetrating power, one of which is the same as the defining power, the other depending upon a different cause; and hence the term penetration or penetrating power should be laid aside, as tending to cause confusion, the properties of object-glasses being reducible simply to their defining power and their angular aperture.

The defining power should be tested upon the different objects mentioned below in connexion with each object-glass, and the angular aperture should be determined by measurement (ANGULAR APERTURE); for judgment founded upon the examination of the valves of the Diatomaceæ may be very fallacious to an unpractised observer, on account of the influence of the obliquity of the light, and of the correcting adjustment. If, however, an opinion is to be formed in this way, the valves should be examined by oblique light thrown from all sides, as with the central stop in the condenser, so that the dots may be viewed; for an object-glass may show the lines very fairly, but the dots very badly.

4. The correcting adjustment is of importance in examining very delicate objects or structures with the high powers; it should therefore always be present.

We subjoin, in connexion with each object-glass, the magnitudes of the angle of aperture which they usually have in this country, and which may be regarded as standards for comparison; also those objects which will be found most suitable for the purpose of testing an object-glass.

$1\frac{1}{2}$ *or 2-inch object-glass.* Magnifying power 20 diameters; angular aperture 12° to 20°.

Test-objects: the pygidium of the flea (Pl. 1. fig. 13 *a*), in which the general outline and the hairs should be distinct; the hair of the mouse (Pl. 1. fig. 3). Also, as an opaque object, a piece of an injected preparation (Pl. 31. figs. 33–35).

1-*inch or* $\frac{2}{3}$*rds object-glass.* Magnifying power 60 diameters; angular aperture 22° to 35°.

Tests: hair of *Dermestes* (Pl. 1. fig. 1); of the bat (Pl. 1. fig. 2); of the mouse (Pl. 1. fig. 3); the pygidium of the flea, the outline of the areolæ being distinguishable under the high eyepiece (120 to 200 diameters), but not the rays. Also an injection, as a piece of lung.

$\frac{1}{2}$-*inch or* $\frac{4}{10}$*ths-inch object-glass.* Magnifying power 100 to 120 diameters; angular aperture 65°.

Tests: hairs (Pl. 1. figs. 1, 2, 3); the disks on deal (Pl. 1. fig. 4); the coarser scales of *Lepisma* (Pl. 1. fig. 6 *a*); the pygidium of the flea (Pl. 1. fig. 13 *a, b*), the entire structure visible under the high eyepiece; a dark scale of *Podura* (Pl. 1. fig. 12 *b*).

$\frac{1}{4}$-*inch object-glass.* Magnifying power 220 diameters; angular aperture 75° to 140°.

Tests: hair of *Dermestes*; the disks of deal; the salivary corpuscles (Pl. 1. fig. 5), the moving molecules being clearly distinguishable; the smaller scales of *Lepisma* (Pl. 1. fig. 6 *a, b*); the scales of *Podura*; the filaments of *Didymohelix* (Pl. 1. fig. 10 *a*); the pygidium of the flea, and the scales of *Pontia brassicæ* (Pl. 27. fig. 24).

$\frac{1}{8}$*th-inch object-glass.* Magnifying power 420 to 450 diameters; angular aperture 110° to 150°.

Tests: the paler scales of *Podura*; the pygidium of the flea; the scales of *Pontia brassicæ*; the filaments of *Didymohelix*, showing the component fibres; the salivary corpuscles.

$\frac{1}{12}$*th or* $\frac{1}{16}$*th-inch object-glass.* Magnifying power 600 to 650 diameters; angular aperture 80° to 170°.

Tests: the paler scales of *Podura*; the filaments of *Didymohelix* mounted in balsam; and the primitive fibrillæ of muscular fibre (Pl. 17. fig. 36 *b, d*).

It will be observed that we have omitted the tests for angular aperture, which many of our microscopists look upon as the true tests of the value of an object-glass. Our reasons for this are given in the INTRODUCTION (p. xv). Those, however, who wish for an interesting series of difficult objects in this respect, will find one in the valves of *Gyrosigma*, *Grammatophora*, *Fragilaria*, *Rhipidophora*, *Amphipleura*, some species of *Nitzschia*, as *N. tænia*, and *Berkeleya* (see those articles). We regard large angular aperture in an object-glass as of little importance, because it is only of service for showing the markings upon the valves of the Diatomaceæ, and the time is probably near at hand when the presence and size of

these will be shown to possess neither generic nor specific importance; moreover, object-glasses of large aperture and high power approach so nearly to the object, that they are inapplicable to important physiological investigations. This defect, however, is considerably obviated in the new high powers.

We shall now offer a few

General remarks on the application of test-objects to the choice of an object-glass. A great difficulty presents itself in this question in the case of persons commencing the use of the microscope; for on viewing almost any object, they will see so much that was invisible before, that they are naturally led to regard an object-glass as good which may simply possess tolerable magnifying power.

There is also some difficulty to an unpractised eye in discriminating between a well-defined margin of an object, and one which is ill-defined. This may be overcome by purchasing one or two test-objects from those who mount objects for sale, and first viewing them under their microscopes; or by examining some of the objects exhibited at the evening meetings of the learned societies.

The objects themselves are also variable, some being much more delicate than others even of the same kind. The best plan in regard to this point is to select an object, as the scale of an insect or whatever it may be, in which the test-structure is not distinguishable under the next highest power, and then to examine the same object under the power to be tested.

The manner in which objects are mounted is also of importance; for if they be immersed in too much balsam or covered by too thick a cover, no object-glass will show them well, however good it may be. Hence the necessity of purchasing the test-objects, in the case of an inexperienced observer. They may be obtained from Mr. Norman, Fountain Place, City Road; Mr. Baker, 244 High Holborn; or of Messrs. Smith and Beck, Ross, or Powell.

A few notes upon the test-objects themselves may not be out of place here.

Hairs of animals (Pl. 1. figs. 1–3). These should be mounted in Canada balsam. Many of those represented in Pl. 22 might be used with equal advantage.

Disks of deal (Pl. 1. fig. 4), form a good test-object on account of their freedom from colour, whence the colours from uncorrected chromatic aberration are easily seen with a bad object-glass.

Salivary globules (Pl. 1. fig. 5 *a, b, c*). Obtained from the saliva. A good test-object for those engaged in physiological investigations; the marginal granules and the moving molecules should be very distinct.

Scales of insects (Pl. 1. figs. 6 *a, b, c*, 12 *a, b, c*; Pl. 27. fig. 24). These should be mounted dry. The scales of *Tinea* and many others have nothing to recommend them. Nor do we advise the use of those scales which exhibit the transverse striæ by oblique light, as those of *Morpho* (Pl. 1. fig. 7), of *Hipparchia* (Pl. 1. fig. 9), &c., as they are easy tests even to inferior English object-glasses of the present day. The long scales of *Pontia brassicæ*, however, are good.

Didymohelix (Pl. 1. fig. 10 *a, b, c, d*). The filaments should be mounted in solution of chloride of calcium, or in Canada balsam. It is very difficult to display the component fibres of this beautiful object when in balsam. It also forms a good test of magnifying power.

Didymoprium (Pl. 1. fig. 11). The longitudinal lines upon the cells require considerable magnifying power.

The pygidium of PULEX. An excellent test-object, mounted in as small a quantity of balsam as possible. Dujardin represents the rays upon the disks as round, like so many beads, whereas they are wedge-shaped with the bases outwards.

The valves of the Diatomaceæ. It is a difficult matter to show the lines upon *Grammatophora marina* with an object-glass of 110° of angular aperture, requiring extremely oblique light.

The ultimate fibrillæ of muscular fibre. Mounted in liquid. Kölliker represents them as beaded (Pl. 17. fig. 36 *c*); they have also been represented as in *a*: probably both these inaccuracies arise from imperfect adjustment, and from their immersion in too much liquid. Their true structure is figured in *b, d, f*.

Nobert's test-lines. See NOBERT'S LINES.

We have omitted to notice several test-objects, as the scales of some insects, a minute globule of mercury, &c.; and this advisedly, because the former have been so obscurely described that we are unable to comprehend in what the test-structure consists; and the test-appearances presented by the latter viewed as an opaque object are inappreciable to one unaccustomed to the use of the microscope, by whom mainly are remarks upon test-objects required.

Amici's test-object is *Navicula gracilis*, the display of the lines forming the test; it is a test for angular aperture.

Chevalier's test-object consists of the scales of *Pontia brassicæ* (Pl. 27. fig. 24), the granules being rendered distinct; this is a test for definition.

Mohl recommends the scales of *Hipparchia janira* for testing "penetrating" power; pollen-grains, the scaly elytra of the diamond-beetle, or bat's hair, for "definition."

Schacht's test-object consists of the scales of *Hipparchia janira* (Pl. 1. fig. 9 *c*) (a test for moderate angular aperture and oblique light).

Bibl. That of the Introduction (p. xl), and of Angular aperture. See Royston Pigott, *Qu. Mic. Jn.* and *Mo. Mic. Jn.* passim.

TE'THEA, Lam.—A genus of marine Sponges.

Char. Solid and compact, rounded, covered with a skin; without sensible pores; interior fleshy, with acicular and globulo-subulate spines (Pl. 36. fig. ε).

Bibl. Johnston, *Brit. Spong.* p. 81; Gosse, *Mar. Zool.* i.; Huxley, *Ann. Nat. Hist.* 1851, vii. p. 370.

TETMEM'ORUS, Ralfs.—A genus of Desmidiaceæ.

Char. Cells single, simple, elongated, straight, cylindrical or fusiform, constricted in the middle; segments emarginate at the ends.

Sporangia square or round.

1. *T. granulatus* (Pl. 10. figs. 33, 34). Cells fusiform both in front and side view, ends colourless and lip-like; dots irregular. Length 1-130″.

2. *T. lævis* (Pl. 10. fig. 35, in conjugation). Cells in front view somewhat tapering, ends truncate; side view fusiform; dots none, or very indistinct (under ord. illum.). Length 1-350″.

3. *T. Brebissonii.* Dots in longitudinal rows.

Bibl. Ralfs, *Brit. Desmid.* p. 145; Rabenht. *Fl. Eur. Alg.* iii. p. 139; Pritchard, *Infus.* 746.

TETRACHAS'TRUM, Rabenht.—A subgenus of Micrasterias.

Bibl. Rabenht. *Fl. Eur. Alg.* iii. p. 109.

TETRACTIN'IUM, Brown.—A subgenus of Pediastrum.

Bibl. Rabenht. *Fl. Eur. Alg.* iii. p. 77.

TETRACY'CLUS, Ralfs.—A genus of Diatomaceæ.

Char. Frustules compound, aggregated into a filament, in front view broadly tabular with longitudinal interrupted vittæ; valves inflated on each side in the middle.

Valves with coarse transverse striæ.

T. Thienemanni, Ehr. (*lacustris*, Ralfs) (Pl. 13. fig. 28). Valves rounded or subacute at ends, inflations rounded.

T. emarginatus. As the last, but valves constricted towards the rounded and subapiculate ends, and the inflations emarginate.

Bibl. Ralfs, *Ann. Nat. Hist.* 1843, xii. p. 105; Kützing, *Sp. Alg.* p. 118; Smith, *Brit. Diat.* ii. p. 37; Rabenht. *Fl. Eur. Alg.* i. 302.

TETRAN'YCHUS, Duf.—A genus of Arachnida, of the order Acarina, and family Trombidina.

Char. Palpi incumbent upon the rostrum, stout, short, and conical; mandibles and labium as in *Raphignathus*; coxæ inserted in two groups on each side, one for the two anterior, the other for the two posterior; anterior legs longest, third joint (femur) largest; claws short and greatly curved.

Several species.

1. *T. glaber* (Pl. 2. fig. 32).

2. *T. lapidum* (*cristatus*) Dugès (Pl. 2. fig. 35).

Bibl. Dugès, *Ann. des Sc. Nat.* 2 sér. i. 24, & ii. 55; Gervais, *Walckenaer's Aptères*, iii. 165; Dufour, *Ann. des Sc. Nat.* 1 sér. xxv. 279; Koch, *Deutschl. Crustac.*

TETRAPE'DIA, Reinsch.—A genus of Unicellular Algæ.

Char. Cells compressed, quadrangular or triangular equilateral, becoming subdivided into quadrate or connate segments or rounded lobes, either by deep vertical or oblique markings, or by wide angular or rounded sinuses (Archer).

Bibl. Archer, *Qu. Mic. Jn.* 1872, p. 351.

TETRAP'LOA, Berk. and Br.—A genus of Torulacei (Coniomycetous Fungi), comprising at present a single species, *T. aristata*, a curious little fungus growing upon leaves of grass. See Torulacei.

TETRAP'LODON, Br. and Sch.—A genus of Splachnaceæ (Acrocarpous operculate Mosses).

TETRAS'PORA, Link.—A genus of Palmellaceæ (Confervoid Algæ), nearly related to the Ulvaceæ; indeed it is very difficult to draw any very distinct line of demarcation between *Tetraspora* and Monostroma, the fronds of both of which are membranous strata formed of a single layer of cells; the latter, however, has its constituent cells crowded, while in *Tetraspora* the green 'cell-

contents' lie scattered, mostly in groups of two or four, in the gelatinous frond. Thuret states that the primordial utricles of the cells possess long cilia in the stage when they are imbedded in a continuous frond (Pl. 3. fig. 10). The history of development of this genus is imperfectly known at present: the ciliated cell-contents break out as swarming zoospores; but their next following changes have not been observed. Two recorded British species appear to be distinct, growing in stagnant pools (see MONOSTROMA, MERISMOPÆDIA, and SARCINA).

1. *T. gelatinosa* (Pl. 3. fig. 10). Frond gelatinous, soft, of irregular shape and division, pale green; cells 1-10800 to 1-4200″ in diameter (Kützing, *Tab. Phyc.* i. p. 28).

2. *T. lubrica.* Frond green, elongated, mesentery-shaped, lobed and sinuated, lobes often anastomosing; cells angulo-globose, 1-3600″ in diameter (Kützing, *l. c.* pl. 30).

BIBL. Hassall, *Brit. Fr. Alg.* p. 300, pl. 78; Kützing, *Sp. Alg.* p. 225; *Tab. Phyc.* i.; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 248, pl. 21; Nägeli, *Einzell. Alg.* p. 71, pl. 2; Rabenht. *Fl. Eur. Alg.* iii. p. 28.

TETRASPORES. See SPORES.

TETRATAX'IS, Ehr. — A Valvuline Foraminifer, with four chambers in a whorl. Fossil (Carboniferous).

BIBL. Parker and Jones, *Ann. N. H.* 4, x. 259.

TEXTULA'RIA, Defrance (TEXTILARIA, Ehr.).—A protean genus of hyaline Foraminifera, having typically a binary series of subglobular or subquadrate chambers arranged alternately on two sides of a longitudinal axis, and usually increasing in size from the oldest (at apex) to the youngest, with a slit-like aperture in the inner wall of each chamber (*T. cuneiformis*, Pl. 18. fig. 47). The shell is flattened in one direction in *Vulvulina*, with oblique chambers and terminal slit, *V. gramen* (Pl. 18. fig. 49); in another, in *Cuneolina*, with transverse chambers and a row of apertural pores in normal position. Biserial chambers passing into a single or linear row constitute *Heterostomella*, with few uniserial chambers and necked and rimmed aperture, and *Bigenerina*, with many such, and a terminal pouting mouth (*B. agglutinans*, Pl. 18. fig. 50). Instead of the biserial form, frequently the shell begins with a triserial arrangement of chambers (*Verneuilina*, with contracted aperture; *Candeina*, with perforate septa). The Verneuiline commencement is often succeeded by the usual two alternating rows (*Gaudryina*, *G. pupoides*, Pl. 18. fig. 48), or by a linear growth with terminal aperture (*Tritaxia*). The triserial varieties are sometimes twisted. If *Vulvulina* takes on the linear growth, we have *Venilina*.

The early chambers of *Textilaria* and its modifications are not unfrequently coiled (*Spiroplecta*). *Textilaria* (*Sp.*) *annectens* (Pl. 18. fig. 52), from the Gault, commenced spirally, proceeded biserially, and ended with uniserial chambers.

Large *Textilariæ* are rarely porous and translucent; they usually become sandy (*Plecanium*).

Common in all seas, and fossil in all formations from the Carboniferous upwards.

BIBL. D'Orbigny, *For. Foss. Vien.* 245; Williamson, *Rec. Brit. For.* 75; Morris, *Cat. Brit. Foss.* 43; Bronn, *Index Pal.* art. *Text.*; Ehrenberg, *Mikrogeologie*, passim; Schultze, *Org. Polyth.* 62; Carpenter, *Introd. For.* 189; Parker and Jones, *Ann. N. H.* 3, xi. 91; 4, ix. 298; x. 189, 196, 259.

THALAMOP'ORA, Reuss. — A large, subcylindric, zoophytoid Foraminifer, composed of superimposed chambers, with labyrinthic and perforated walls, arranged around, and opening into, a central vertical cavity. *Thalamopora* exhibits characters of alliance with *Polytrema*, *Carpenteria*, *Tinoporus*, *Cymbalopora*, and, through the last, with *Planorbulina* and others of the *Rotalina*. It is among the Perforata what *Dactylopora* is among the Imperforata.

BIBL. Reuss *in Geinitz' Elbthalgebirge*, 1872, p. 139.

THALASSICOL'LIDA, Huxley. — A family of Rhizopoda.

Char. Furnished with structureless cysts containing cellular elements and sarcode, and surrounded by a layer of sarcode giving off pseudopodia, which commonly stand out as rays, but may run into each other and form a network. The Thalassicollida may be simple or composite, the latter consisting of aggregations of the former; whilst these are essentially composed of a mass of granular sarcode with a nucleus, but without a contracting vesicle, enclosed in a membranous capsule, which is in turn protected by a more or less thick gelatinous exudation. Numerous sarcoblasts occur scattered through the endosarc; and occasionally a few may be seen suspended within the external gelatinous structure (Wallich). The whole organism is permeated by spicula, or sustained by a fenestrated shell. The commonest genera are *Sphærozoum*, *Collosphæra*,

and *Thalassicolla*. All are marine in tropical and subtropical seas.

BIBL. Nicholson, *Zoology*; Huxley, *Ann. Nat. Hist.* 2 ser. viii. 1851, p. 489; *Qu. Mic. Jn.* iv. 1856, p. 72; Müller, *Ueber die Thalass. &c.*; Haeckel, *Die Radiolarien*, Berlin, 1862; Wallich, *Ann. Nat. Hist.* 1869, iii. 97.

THAL'LUS. See LICHENS.

THAMNO'LIA, Ach.—A genus of Lichenacei.

Char. Thallus consisting of stipites or podetia, which are cylindrical or subcompressed, connate, imperforate, simple or branched, apices acute, internally fistulose. Apothecia unknown. Spermatia cylindrical.

BIBL. Leighton, *Brit. Lich. Flora*, p. 82.

THAMNOM'YCES, Ehr.—A genus of Sphæriacei (Ascomycetous Fungi). It has distinct asci and sporidia.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 284; Fries, *Summa Veg.* p. 382.

THAUMAN'TIAS, Eschscholtz. — A genus of Campanulariidæ.

Char. Stem simple (or branched?), rooted by a thread-like stolon; hydrothecæ campanulate; polypites with a funnel-shaped proboscis; reproduction by free medusiform zooids. Gonozooid: umbrella hemispherical, manubrium four-lipped, radiating canals four, marginal tentacles numerous; sporosacs in the centre of the radiating canals.

T. inconspicua, Forbes. Common off the Hebrides.

BIBL. Hincks, *Brit. Hyd. Zooph.* p. 178.

THAUMATONE'MA, Grev.—A genus of Diatomaceæ.

BIBL. Grev. *Mic. Trans.* 1863, p. 76.

THECA.—A term used very loosely in the descriptions of Cryptogamic plants. In the case of the Lichens and Fungi it is synonymous with ASCUS, a sac in which free spores are developed; these are called *thecaspores* or ascospores, in contrast with BASIDIOSPORES or stylospores. In the higher Cryptogamia, as Ferns, &c., it is used in the sense of *sporangium*.

THECAMONADI'NA, Duj.—A family of Infusoria (=Cryptomonadina and some Astasiæa, E.).

Char. Usually coloured; covered with a non-contractile tegument, which is either hard and brittle, or membranous; no other locomotive organs present than one or more flagelliform filaments.

Many are Algæ, or their spores. They are minute, usually green, but some are red; and they often colour stagnant water from existing in vast numbers. They are mostly recognizable by their rigidity and the uniformity of their motion.

It is thus subdivided:—

A single flagelliform filament.	Body ovoid or globular	Tegument hard and brittle	1. *Trachelomonas.*
		Tegument membranous	2. *Cryptomonas.*
	Body depressed or foliaceous	with a tail-like prolongation	3. *Phacus* (*Euglena*, pt., E.).
		without a prolongation	4. *Crumenula.*
Two filaments.	Two similar filaments		5. *Diselmis* (*Chlamidomonas*, E.).
	One flagelliform filament, and one trailing retractile filament	Body prismatic or boat-shaped	6. *Plœotia.*
		Body ovoid or pip-shaped	7. *Anisonema.*
	Several filaments	Body prolonged into a point in front	8. *Oxyrrhis.*

BIBL. Dujardin, *Infus.* p. 323.

THECAPH'ORA.—Hydroida with true calycles.

THELID'IUM, Mass.—A genus of Microlichens parasitic on the thallus of Lecanoræ.

Char. Spores subfusiform, 2-locular, colourless.

BIBL. Lindsay, *Qu. Mic. Jn.* 1869, p. 346.

THELOCAR'PON, Nyl. — A genus of Pyrenodei (Lichens), sometimes parasitic.

Char. Thallus thin, crustaceous. Apothecia single in citrine spherical thalline verrucæ; spores numerous (minute ellipsoid, colourless in parasitic species).

BIBL. Leighton, *Brit. Lich. Flora*, p. 407; Lindsay, *Qu. Mic. Jn.* 1869, p. 345.

THELOTRE'MA, Ach.—A genus of Endocarpeæ (Angiocarpous Lichens), containing two British species.

BIBL. Leighton, *Brit. Angioc. Lichens*, p. 31.

THEO'RUS, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes colourless, more than three, cervical, in two groups; foot forked; jaws each with a single tooth.

1. *T. vernalis* (Pl. 35. fig. 32). Toes small, frontal hook absent. Aquatic; length 1-140 to 1-120″.

2. *T. uncinatus.* Toes long, frontal (or rather cervical) region with hooks. Aquatic; length 1-240″.

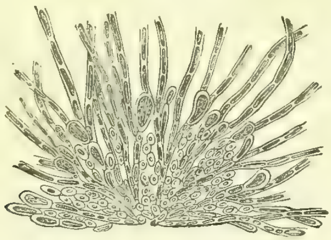
BIBL. Ehr. *Infus.* p. 454; Pritchard, *Infus.* p. 690.

THLIPSU'RA, J. & H.—A Cytheroid Ostracode in the Silurian strata.

BIBL. Jones and Holl, *Ann. N. H.* 4, iii. 213.

THO'REA, Bory.—A genus of Batrachospermeæ (Confervoid Algæ), of which one species (*T. ramosissima*) occurs in Britain; its fronds are branched filaments, a foot or more long, about as thick as a crow-quill, with a villous surface, of olive-black

Fig. 740.



Thorea ramosissima.

Horizontal section of a filament (halved). The semicircular denser portion represents the axis, the loose spreading branches the villi. Magnified 25 diameters.

colour. The filaments are composed of radiating branched cells, closely compacted into a kind of solid axis, from which proceed lax, radiating ramuli (forming the villous surface). The spores (or sporangial cells) arise from these ramules (fig. 740).

Bibl. Kütz. *Phyc. generalis*, pl. 16, *Sp. Alg.* p. 534; *Eng. Bot.* Supp. No. 2948; Hassall, *Brit. Fr. Alg.* p. 64; Rabenht. *Fl. Eur. Alg.* iii. p. 418.

THREAD-CELLS, also called filiferous capsules, urticating, stinging organs or nematocysts. See Hydra and Zoantharia.

THUIA'RIA, Flem.—A genus of Polypi, of the order Hydroida, and family Sertulariadæ.

Char. Those of *Sertularia*; but the cells closely pressed to or imbedded in the stem or branches. Two species:

1. *T. thuia.* Cells ovate-elliptical, acutish; vesicles pear-shaped. On shells from deep water.

2. *T. articulata.* Cells ovate, obtuse or truncate, vesicles elliptical; rare.

Bibl. Johnston, *Brit. Zooph.* p. 83; Gosse, *Mar. Zool.* ii. p. 23; Hincks, *Brit. Hyd. Zooph.*

THU'JA, L.—A genus of Coniferæ (Gymnospermous Plants), to which belongs the *arbor vitæ* of gardens, *Thuja occidentalis*; *T. orientalis* is placed by some authors under another genus, *Biota.* The characters of Coniferous wood, Gymnospermous ovules, &c., may be observed in these plants (see Coniferæ and Ovule).

THYMELEA'CEÆ.—An order of Dicotyledons to which the Spurge-Laurels (*Daphne*) belong. In *D. Lagetto* (=*Lagetta lintearia*) the fibres of the liber are separated into lozenge-shaped meshes, arranged in such beautiful and easily-separable layers, as to have acquired for the plant the name of the Lace-Bark Tree.

See Liber.

THY'MUS GLAND.—A lobulated gland lies behind the upper part of the sternum in the fœtus and young of man and the mammalia, and is called the thymus gland. It belongs to the lymphatic system in all probability; and its general anatomy is to be found in all standard works on anatomy and physiology. The histological elements of the gland are the structures of the investing capsule, the tissue bounding the follicles, the follicles and trabecular structures, and the vessels. The capsule exhibits the usual structure of membranous connective tissues: its elements are wavy connective-tissue fibres united into fasciculi of various sizes, which decussate in all directions, and thus form a tolerably resistant membrane; fine elastic fibrils which are partly united in a plexiform manner, and partly form large arches running in an irregular manner between the fibres of the connective tissue; a few lustrous, broad, strongly refracting bands, characterized by their looped course and resistance to the action of acids; and, lastly, cellular elements. These either resemble colourless blood-corpuscles, or are provided with processes like the so-called stellate cells, or they may appear as large, finely-granular, irregularly shaped bodies, usually containing a single small, spheroidal, highly refracting nucleus. On the outer surface of the capsule there is a single layer of basement epithelium, the cells being polyhedral or slightly elongated or rhombic in form, and containing a vesicular, spheroidal, or elliptical nucleus. If a portion of the capsule be spread out (dog) upon a slide with the aid of some indifferent fluid, and examined with a high power, besides the tissues and structures abovementioned, we may discern the deeply situated ramifications of the blood-vessels, together with a few medullated nerve-fibres, and, lastly, certain peculiar cavities. These are in the intervals of fasciculi of connective tissue, and are lined with large long fusiform cells. They are lymphatic vessels; but the quantity of lymph-cells they contain is small. The tissue bounding the follicles,

and dipping down into the interior of the organ from the surface of the lobules, consists of a network of connective tissue, which (in dog) is composed of fine fibres arranged in the form of delicate rhombic meshes. These are generally filled with more or less closely packed large cells; but near the free surface of the follicles, where they are not confluent with one another, the cells are crowded and smaller, and the tissue becomes condensed so as to form a capsule. The individual follicles are thus entirely capsuled and isolated (calf); or several may be united at their centric portion, as in man and the dog. On the whole their structural characters are comparable to those of Peyer's patches of the small intestine. The form of the follicles is elongated, spheroidal, or polyhedral; and the superficial are the largest. The finer structure of the follicles displays the same morphological elements, with the same relative disposition, as the ordinary lymph follicles. Fine capillary blood-vessels, proceeding from the vessels running in the septa, penetrate the follicles at numerous points of their surface, and in consequence of these frequent anastomoses form a very close-meshed plexus. Between the vessels, and attached to them as well as to the connective tissue of the septa, an exceedingly compact but very delicate network is extended, chiefly formed by the anastomosing branches of multipolar cells, in the interstices of which are numerous lymph-cells. The network is the prolongation of the interfollicular lymphatic vessels; and this is the case with a second network with narrow meshes without cells. There is moreover a third kind of trabecular structure in the form of strong elongated fibres, which are stretched between adjoining vessels, or between these and the septa of connective tissue. These are not much branched, and are attached to the vessels by conical longitudinal striated bases. The contents of the follicles consist of cells, which, according to their size, may be arranged in three categories. The first and most numerous are ordinary lymph corpuscles; the second are larger coarsely granular spheroidal bodies, composed of protoplasm, and containing one or several nuclei; and the third are Hassall's concentric corpuscles, of which Ecker recognizes two forms. These cells increase in abundance as the gland approaches maturity. One kind consists of spheroidal vesicles, containing in the interior of their concentrically striated sheath sometimes only a homogeneous mass with a fatty lustre, but sometimes a nucleus and granular material; and the second kind is composed of several vesicles that are collectively invested, and united together by a concentrically striated membrane.

Bibl. E. Klein *in Stricker's Hum. & Comp. Hist.* vii. (from which this description has been taken); J. Simon, *A Physiological Essay on the Thymus Gland*, London, 1845; His, *Sieb. u. Köll. Zeit.* B. x. p. 333; Ecker, *Blutgefässdrüsen in R. Wagner's Handwörterb.* B. i. p. 115.

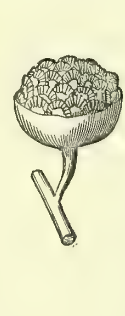
THYRSOPOREL'LA, Gümb.—Gümbel divides the *Dactyloporideæ* (see Dactylopora) into (I.) those with chambers:—1. *Haploporella*; segmental, annular, or cylindrical (piled rings), with large chambers and simple traversing canals (6 species, recent and Tertiary): 2. *Dactyloporella*; cylindrical, with large and subsidiary chambers, and branched traversing canals (4 species, Tertiary). (II.) Those without chambers:—3. *Thyrsoporella*; cylindrical, with simple, swollen, traversing canals, and fascicules of smaller tubes (2 species, Tertiary): 4. *Gyroporella*; cylindrical, with circular canals (14 species, Triassic and Neocomian): 5. *Uteria*; annular, hollow, perforate (1 species, Tertiary).

Bibl. Gümbel, *Abhandl. k. bayer. Akad. Wiss.* II. *Cl.* xi. 1872, p. 231.

THYRSOP'TERIS, Kunze.—A genus of Dicksonieæ (Polypodioid Ferns), with a curious structure of the fertile fronds. Exotic (figs. 741–4).

Fig. 741.

Fig. 742.

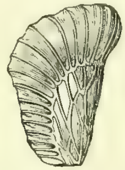


Thyrsopteris elegans.

Fig. 741. A fertile pinna.

Fig. 742. A pinnule converted into a cup-like sorus. Magnified 20 diameters.

Fig. 743. Fig. 744.



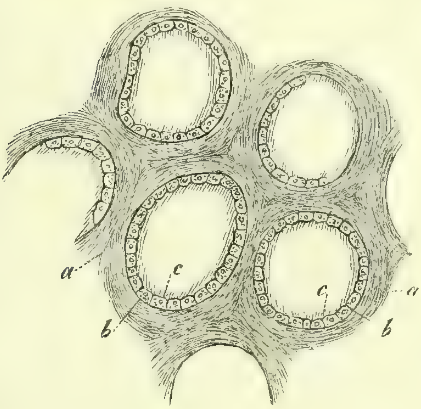
Thyrsopteris elegans.

Fig. 743. Vertical section of the same, with the sporanges removed from the columella.
Fig. 744. Side view of a sporange. Magn. 100 diams.

THY'ROID GLAND.—The thyroid gland is one of the vascular glands, or glands without ducts.

It consists of rounded, closed, glandular vesicles (fig. 745) surrounded by or imbedded

Fig. 745.



Glandular vesicles from the thyroid gland of a child. *a*, intervening areolar tissue; *b*, basement membrane; *c*, epithelium.

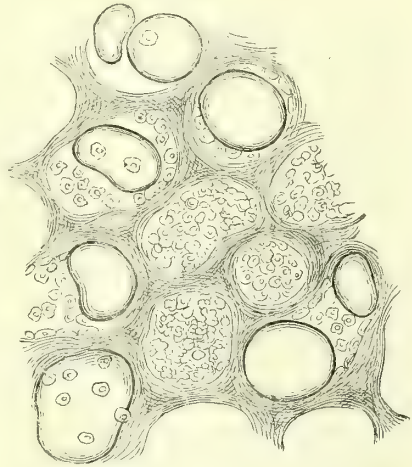
Magnified 250 diameters.

in a fibrous stroma (*a*), and aggregated into roundish, elongate, or somewhat polygonal acini or minute lobules, these being grouped in secondary lobules, which unite to form lobes. The vesicles are from 1-600 to 1-240″ in diameter, the acini from 1-50 to 1-24″. The stroma is condensed around the lobules, to form a fibrous coat.

The stroma consists of ordinary interlacing bundles of areolar tissue, with fine elastic fibres, at its outer surface containing fat-cells.

The vesicles consist of a basement membrane (fig. 745 *b*), lined by a single layer of polygonal epithelial cells (*c*), and containing a yellowish, tenacious, albuminous liquid.

Fig. 746.



Glandular vesicles with colloid matter.

Magnified 50 diameters.

The capillaries form plexuses surrounding the vesicles.

In *goître*, the vesicles become greatly enlarged, and confluent, so as to form cysts containing colloid matter, with fat-globules and crystals of cholesterine. The same conditions, in a minor degree, are so frequently met with, that they can scarcely be regarded as abnormal. The epithelium is also often found loose in the vesicles (fig. 746). The minute arteries and capillaries are often found varicose.

Bibl. Kölliker, *Mikrosk. Anat.* ii. 327; Förster, *Pathol. Anat.* ii. 233; E. Verson *in Stricker's Hum. & Comp. Hist.* i. p. 370.

THYSANU'RA.—An order of Insects, to which *Lepisma* and *Podura* belong.

See Insects.

TICHOTHE'CIUM, Fv.—A genus of Micro-lichens parasitic on the thallus of many crustaceous and subfoliaceous lichens.

Bibl. Lindsay, *Qu. Mic. Jn.* 1869, p. 347.

TILLE'TIA, Tulasne.—A genus of Ustilaginei (Coniomycetous Fungi), forming the *Bunt*, a kind of blight of various corn grains, in which the ears are attacked, and the internal substance of the grains is replaced by a fœtid, black powder, consisting of the spores of the fungus. *T. Caries* (*Uredo Caries*, D.C.) attacks wheat and other grain.

The interior of the ovaries of the corn is at first occupied by an interwoven mycelium, from which the globular spores arise on short stalks; as the latter grow, the ears become more or less deformed, the mycelium disappears, and the spores are set free as a pulverulent mass. The spores have a reticulated surface; and their pedicel is often found attached. A distinct species is found in wheat in the United States. (See USTILAGINEI.)

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 375; Tulasne, *Ann. des Sc. Nat.* 3 sér. vii. p. 112, pl. 5; 4 sér. ii. p. 161.

TIM'MIA, Hedw.—A genus of Mniaceous mosses, containing one British species, *Timmia austriaca*, Hedw. (*megapolitana*, Hook. and Tayl.).

TIN'EA, Fabr.—A genus of Lepidopterous Insects, of the family Tineidæ.

The small scales from the underside of the wings of *T. vestianella*, the common clothes' moth, have been proposed as test-objects; but they can hardly be regarded as such for object-glasses of the present day. The longitudinal lines form the test-structure.

BIBL. Westwood, *Introduction, &c.*; Stainton, *Manual of Butterflies, on Tineida.*

TINOP'ORUS, De Montfort.—A many-shaped Foraminiferal genus of the Globigerinida; globular, subhemispherical, lenticular, or stellate; areolated, granulate, and often spined (baculate). Commencing as a spiral Rotaline (like *Calcarina*), it soon heaps on each face subcyclical layers of quadrangular chambers, with cribrate floors and strong, perforated, radiating septa. The spines consist of "supplemental skeleton," arising from some of the early septa, with an extension of the "canal-system." Some of the *Orbitolinæ* of authors belong to *Tinoporus*, others to *Patellina*.

Recent and fossil, often in great abundance, as *T. globularis* of the Chalk, and *T. baculatus* of the Australian seas and the Philippines.

BIBL. Parker and Jones, *Ann. N. H.* 3, vi. 34; Carpenter, *Introd. For.* 223.

TINTINNOID'EA.—A family of Ciliate Infusoria (page 410).

BIBL. Claparède et Lachmann, *Etudes*, p. 192.

TINTIN'NUS, Schrank. — A genus of Infusoria, of the family Tintinnoidea.

Char. Single; body contained in a cylindrical, sessile, bell-shaped carapace, to the bottom of which it is attached by a stalk.

Many species.

T. inquilinus (Pl. 25. fig. 4). Body hyaline or yellowish; carapace cylindrical, hyaline. Marine; length 1-240″.

BIBL. Ehr. *Infus.* p. 294; id. *Ber. d. Berl. Akad.* 1840; Duj. *Infus.* p. 561; Clap. et Lach. *Etudes*, p. 195.

TISSUE, FIBRO-PLASTIC.—A term applied by Lebert to imperfectly developed abnormal areolar tissue. The separate elements are often found diffused through those of normal tissues, or products of inflammatory exudation. They consist of rounded or oblong cells, from 1-2300 to 1-1600″ in diameter, in a more advanced stage becoming fusiform or angular, and finally forming distinct fibres; hence resembling the elements of embryonic areolar tissue (Pl. 40. fig. 43). In some instances the development is arrested at one of the early phases, so that the tissue consists almost exclusively of the rounded or the fusiform cells; and in others, the cells enlarge and produce a number of nuclei or secondary cells (Pl. 30. fig. 10 *c*).

Fibro-plastic tissue or its elements are met with in inflammatory effusions upon the serous and synovial membranes (but rarely), in the interstitial effusions of pneumonia, especially when chronic, in cirrhosis of the liver, in the products of suppurating surfaces, on the surface of chronic ulcers and non-malignant fungoid vegetations, in the soft yellow vascular tissue occupying the cancelli of ulcerated bones, in certain tumours, &c.

BIBL. Lebert, *Physiol. Patholog.*; Wedl, *Patholog. Histolog.*; Förster, *Patholog. Anat.* i.

TISSUES, ANIMAL.—The following synoptical arrangement of the principal animal tissues is intended to facilitate reference to the various articles scattered through the work.

A Simple.

1. *Blastemic* or *protoplastic*	Sarcode.
2. *Membranous*	Basement membrane.
3. *Cellular*	Fatty tissue; nerve-cells; simple cartilage; unstriated muscular fibre.
4. *Blastemic* and *cellular*	Without secondary deposit. True cartilage. With secondary deposit. Bone.
5. *Fibrous*	Areolar (cellular) tissue; tendon; ligament; elastic tissue; muscle.
6. *Fibrous* and *cellular*	Fibro-cartilage.
7. *Tubular*	Without secondary deposit. Vessels. With secondary deposit. Nerve-tubes.

B. Compound. Glands; mucous and serous membranes; skin; synovial membrane; teeth.

TISSUES, CONNECTIVE.—The following is a list of them:—

Connective tissue; its cells:—1. Amœboid. 2. Granular. 3. Fusiform. 4. Stellate. 5. Pigment.

Its varieties:—1. Plexuses and trabeculæ. 2. Retiform. 3. Investing and supporting. 4. Trabeculæ. 5. Intraglandular tissue. 6. Fibrillar.

Cartilage.—Kinds:—hyaline, fibro-cartilage, elastic or reticular cartilage with connective tissue and parenchymatous or cellular cartilage. *Osseous tissue* bone. *Corneal tissue.*

BIBL. Rollett *in Stricker's Hum. & Comp. Hist.* i.

TISSUES, VEGETABLE. — The tissues composing the substance of vegetables are all comparatively slight modifications of one type, being composed of cellulose sacs, or "cells" *par excellence*, varying only in form and consistence and in their mode of union. The tissues may be divided into groups on different principles; but for our purpose a very simple arrangement will suffice, based chiefly on the character of the compound tissues, leaving the secondary divisions to be determined by the nature of the component cells.

1. *Cambium tissue*, occurring in the growing regions of all plants having stems, is composed of minute cells of variable form, densely filled with protoplasm, and without intercellular passages. It is a transitional structure, forming the first stage of all the rest.

2. *Parenchyma*, or "cellular tissue," is composed of cells in which the diameter is not excessive in any one direction, and the walls are comparatively thin. This is divided by authors into many sections, according to the form of the cells, the laxity of their coherence, &c. The only distinctions worth note are between—

  a. *Parenchyma proper*, where the cells have polygonal forms.
  b. *Merenchyma*, where the cells are round, oval, &c.
  c. *Collenchyma*, which is a form of cellular tissue where the walls are greatly thickened with softish secondary deposits; it occurs beneath the epidermis of many herbaceous plants, in the fronds of the larger Algæ, of Lichens, &c.
  d. *Sterenchyma.* A name which might be used to distinguish the bony cellular tissue of shells, stones of fruits, &c.

3. *Prosenchyma.* Cellular tissue, usually forming the mass of wood and various fibrous structures, where the cells are attenuated to a point at each end, the cells, "fibres," being intercalated and applied side to side.

4. *Tela contexta.* This name is used to indicate the interwoven tissue formed by the ramified jointed filaments of the mycelium of Fungi, and the cottony substance in the interior of the thallus of many Lichens.

5. *Fibro-vascular tissue* is composed of vessels, ducts, and prosenchymatous cells or "fibres" associated in various ways, forming fibrous or fibro-vascular bundles, which either remain distinct or cohere to form masses of wood.

  a. *Fibrous bundles*, occurring in liber, in the outer part of many Monocotyledonous stems, and in the stems of Mosses, consist of cords formed of prosenchymatous cells, which are often of great length.
  b. *Fibro-vascular bundles*, composed of vessels and ducts together with prosenchyma, form the "woody fibres" of every part (except the bark) of all plants above the Mosses.
  c. *Clathrate tissue*, found in the bark of Dicotyledons and in the vascular bundles of Monocotyledons (see LIBER).

6. *Laticiferous tissue* and *Reservoirs for Secretion*, composed either of intercellular passages lined by a proper coat, or of lines of cells fused at their ends, so as to form continuous branched canals; they occur in the bark, wood, and pith of the Flowering Plants.

7. *Epidermal tissue.* Composed of cellular tissue, forming a continuous firm layer over the external surface of the higher plants. It is composed usually of a single layer of cells, and presents very varied appendages, such as HAIRS, GLANDS, &c., and is perforated by STOMATA. Its outer surface is rendered dense by the deposit of CUTICLE. The epidermis is replaced, on stems, by the CORK or suberous layer of BARK.

For further particulars see the various heads above-named.

BIBL. General Works on Botany.

TMESIP'TERIS.—A genus of Psiloteæ (Lycopodiaceæ) (fig. 747, p. 784), remarkable for its peculiar habit and bivalved sporanges bursting by a vertical crack.

BIBL. See LYCOPODIACEÆ.

TOBACCO.—The leaves of Tobacco (*Nicotiana Tabacum* and other species) may be distinguished from the leaves of the plants

commonly used for adulteration by the peculiar structure of the EPIDERMIS with its hairs, and the form of the section of its FIBRO-VASCULAR BUNDLES. Paper, which has been sometimes used, is still more readily detected. As in other similar cases, the nature of a foreign ingredient can only be determined by careful comparative investigations.

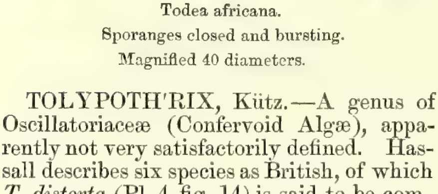
BIBL. Hassall, *Food and its Adulterations*, p. 538; Prescott, *Tobacco and its Adulterations*, London, 1858.

Fig. 747.

Tmesipteris tannensis.

TO'DEA, Willdenow.—A genus of Osmundæous Ferns (fig. 748–50). Exotic.

Fig. 748. Fig. 749. Fig. 750.



Todea africana.
Sporanges closed and bursting.
Magnified 40 diameters.

TOLYPOTH'RIX, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), apparently not very satisfactorily defined. Hassall describes six species as British, of which *T. distorta* (Pl. 4. fig. 14) is said to be common, adhering to sticks, stems, &c. in stagnant water, forming tufts from 1-2 to 1″ in height, dark green when fresh, verdigris- or blue-green when dry; primary filaments 1-1800 to 1-1440″ in diameter; joints about as long as broad. *Tolypothrix Dillwynii*=*Desmonema*, Eng. Bot. Supp. no. 2958.

BIBL. Kütz. *Sp. Alg.* p. 312; *Tab. Phyc.* ii. pls. 31–33; Hassall, *Brit. Freshw. Alg.* p. 240, pls. 68 & 69; Rabenh. *Fl. Eur. Alg.* ii. p. 273.

TONGUE.—For General Anatomy see standard Anatomical Works.

The filiform or conical papillæ (fig. 755) are whitish, very numerous, and occupy the intervals between the fungiform papillæ. The papillæ of the mucous membrane at their bases (*p, p*) are conical, and covered either at the end only, or all over the surface with a number of smaller or secondary papillæ; the whole being coated by an epithelial investment (*e*), terminating in a tuft of free filiform processes (*f*). The inner layers of the epithelium agree in structure with that of the mouth, whilst the outer layers, and especially the epithelium of the processes, resemble rather the scales of the epidermis, in their hardness, small size, and considerable resistance to the action of alkalies and acids. The papillæ themselves consist of areolar tissue, with a large number of undulating nuclear fibres, each containing a small artery (*a*) and vein (*b*), with an intermediate plexus of looped capillaries, and numerous nerve-tubes.

The fungiform or clavate papillæ (fig. 751) are reddish, distributed over the entire surface of the tongue, and are very numerous at its point. Each has at its base a club-shaped mucous papilla, and is covered all over with simple or secondary conical papillæ (*p p*), and a simple epithelial layer (*e*), without filiform processes. The vessels (fig. 752) are more numerous, but otherwise resemble those in the filiform papillæ.

The circumvallate or lenticular papillæ (fig. 753) consist of a flattened central papilla (*A*), surrounded by an elevated wall or ridge (*B*). The flat surface is furnished with crowded conical secondary papillæ (*c*), the whole being covered with epithelium (*a*) free from processes. The wall appears as a simple fold of the mucous membrane, and also exhibits beneath its smooth epithelial coat numerous rows of simple, conical, secondary papillæ. In other respects these papillæ do not differ essentially in structure from the fungiform.

In some of the papillæ of the tongue, axial bodies are found resembling those in the papillæ of the skin.

The epithelial processes of the filiform papillæ are often covered by a fungus (*Leptothrix*), the mycelium closely surrounding them, whilst some of the filaments project from the surface.

The glands of the tongue consist of mucous and follicular glands.

The mucous glands resemble those of the mouth (MOUTH).

The follicular glands are most numerous between the epiglottis and the circumvallate papillæ, and are so superficially situated as to form projections of the mucous membrane. They form lenticular or globular masses, from 1-24 to 1-6″ in diameter, imbedded in the submucous tissue; and in the middle of the free surface is the orifice (754 *d*) of a conical cavity (*e*), formed by a depression of the mucous membrane. Each gland forms a thick-walled capsule, surrounded by a fibrous coat (*c*) continuous

Fig. 751.

Fig. 753.

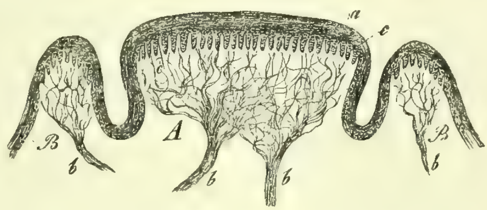


Fig. 752.

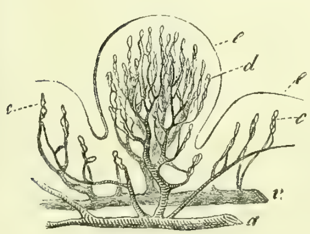


Fig. 754.

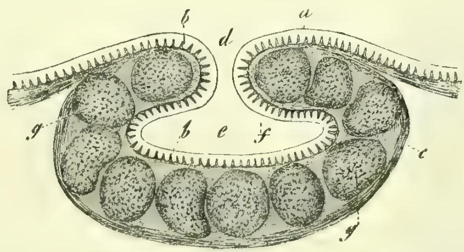


Fig. 751. Fungiform papilla, covered by the epithelium *e* on one side and with the secondary or simple papillæ *p*. Magnified 35 diameters.

Fig. 752. The same, with the vessels; the epithelium *e* represented in outline. *a*, artery; *v*, vein; *d*, capillary loops of the simple papilla; *c*, capillaries in the simple papillæ of the mucous membrane at the base of the fungiform papilla. Magnified 18 diameters.

Fig. 753. Perpendicular section of a human circumvallate papilla. *A*, proper papilla; *B*, wall; *a*, epithelium; *b b*, nerves of the papilla and wall; *c*, secondary papillæ. Magnified 10 diameters.

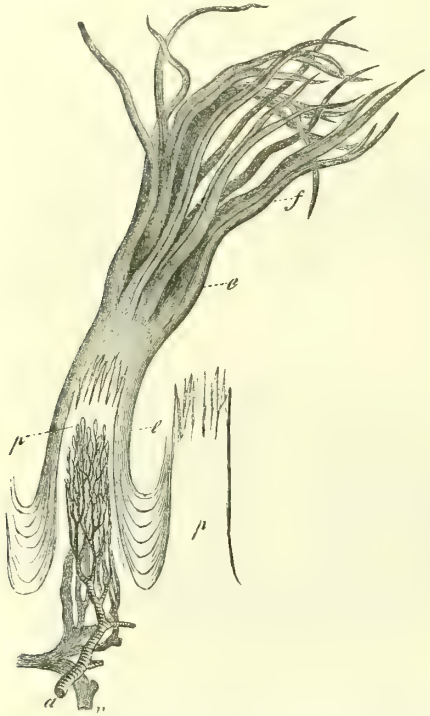
Fig. 754. Follicular gland from the root of the human tongue. *a*, epithelium; *b*, papillæ of the mucous membrane; *c*, areolar coat; *e*, cavity; *f*, epithelium lining it; *g g*, follicles in the thick capsule. Magnified 30 diameters.

with the deeper portion of the mucous membrane, and lined internally by a prolongation of the mucous membrane with papillæ and epithelium (*b*, *a*); and between the two are closed capsules or follicles (*g*), imbedded in a fibrous and vascular basis. The follicles are from 1-120 to 1-48″ in diameter, rounded or somewhat elongate, whitish, composed of a coat of areolar tissue without elastic fibres, and with greyish-white contents consisting of cells 1-6000 to 1-4000″ in diameter and free nuclei.

Beale has investigated the structure of the papillæ of the frog's tongue, and with especial reference to the method of termination of the nerves. He writes:—"In the small portion of tissue constituting one of these papillæ, we see striped muscular fibres, capillary vessels, purely sensitive nervous fibres forming an expanded terminal plexus or network at the summit of the papilla, motor nerve-fibres distributed to the muscle, nerve-fibres around the capillary vessels, and a few very fine nerve-fibres ramifying in different parts of the papillæ. All these are imbedded in and held together by connective tissue, forming the body of the papilla, the summit of which is surmounted by a peculiar epithelium-like tissue, perhaps connected with the nerves and belong-

ing to nerve-texture, while its sides are covered with ordinary ciliated epithelium. These papillæ have been studied by numerous observers; and, strangely enough, the latest writer has seen far less than many

Fig. 755.



Two human filiform papillæ, one with epithelium. *p, p,* papillæ; *a, v,* artery and vein, with the capillary loops; *e,* epithelial covering; *f,* its processes.

Magnified 35 diameters.

of his predecessors, probably because he has been less successful in preparing his specimens."—How to Work, 4th edit. p. 334.

Bibl. Todd and Bowman, *Physiology*; Ward, *Todd's Cycl. Anat. Phys.*; Salter, *Todd's Cycl. Anat. & Phys.*; Huxley, *Mic. Jn.* ii. p. 74; Beale, *Phil. Trans.* 1864; *How to Work*; Hartmann, *Müller's Archiv*, 1863; Klein and Verson *in Stricker's Hum. & Comp. Hist.* v. 1.

TONGUES AND TEETH of Mollusca.— *Tongue of Gasteropod Mollusks.* The organ which is commonly known under this designation is one of a very singular nature, and we should be altogether wrong in conceiving of it as having any likeness to that on which our ordinary ideas of such an organ are founded; for instead of being a projecting body lying in the cavity of the mouth, it is a tube that passes backwards and downwards beneath the mouth, its hinder end being closed, whilst in front it opens obliquely upon the floor of the mouth, being (as it were) slit up and spread-out so as to form a nearly flat surface. On the interior of the tube, as well as on the flat expansion of it, we find numerous transverse rows of minute teeth, which are set upon flattened plates—each principal tooth sometimes having a basal plate of its own, whilst in other instances one plate carries several teeth. Of the former arrangement we have an example in the tongue of many terrestrial Gasteropods, such as the snail (*Helix*) and slug (*Limax*), in which the number of plates in each row is very considerable, amounting to 180 in the large garden slug (*Limax maximus*); whilst the latter prevails in many marine Gasteropods, such as the common whelk (*Buccinum undatum*), the tongue of which has only three plates in each row, one bearing the small central teeth, and the two others the large lateral teeth. The length of the tongue, and the number of rows of teeth, vary greatly in different species. Generally speaking, the tongue of the terrestrial Gasteropods is short, and is contained entirely within the nearly globular head; but the rows of teeth, being closely set together, are usually very numerous, there being frequently more than 100, and in some species as many as 160 or 170; so that the total number of teeth may mount up, as in *Helix pomatia*, to 21,000, and in *Limax maximus* to 26,800. The transverse rows are usually more or less curved, whilst the longitudinal rows are quite straight; and the curvature takes its departure on each side from a central longitudinal row, the teeth of which are symmetrical, whilst those of the lateral portions of each transverse row present a modification of that symmetry, the prominences on the inner side of each tooth being suppressed, whilst those on the outer side are increased, this modification being observed to augment in degree as we pass from the central line towards the edges. The tongue of the marine Gasteropods is generally longer, and its teeth larger; and in many instances it extends far beyond the head, which may, indeed, contain but a small part of it. Thus in the common

limpet (*Patella*) we find the principal part of the tongue to lie folded up, but perfectly free, in the abdominal cavity, between the intestines and the muscular foot; and in some species its length is twice or even three times as great as that of the entire animal. In a large proportion of cases these tongues exhibit a very marked separation between the central and the lateral portions—the teeth of the central band being frequently small and smooth at their edges, whilst those of the lateral are large and serrated. The tongue of *Trochus zizyphinus* is one of the most beautiful examples of this form—not only the large teeth of the lateral bands, but the delicate leaf-like teeth of the central portion having their edges minutely serrated. A yet more complex type, however, is found in the tongue of *Haliotis*, in which there is a central band of teeth having nearly straight edges instead of points, then, on each side, a lateral band consisting of large teeth shaped like those of the shark, and beyond this, again, another lateral band on either side, composed of several rows of smaller teeth. Very curious differences also present themselves among the different species of the same genus. Thus in *Doris pilosa* the central band is almost entirely wanting, and each lateral band is formed of a single row of very large hooked teeth, set obliquely, whilst in *Doris tuberculata* the central band is the part most developed, and contains a number of rows of conical teeth, standing almost perpendicularly, like those of a harrow. Many other varieties might be described did space permit; but we must be content with adding that the form and arrangement of the teeth afford characters of great value in classification, as was first pointed out by Prof. Lovén (of Stockholm) in 1847, and has been since very strongly urged by Dr. J. E. Gray, who considers that the structure of the tongue is one of the best guides to the natural affinities of the species, genera, and families of this group, since any important alteration in the form or position of the teeth must be accompanied by some corresponding peculiarity in the habits and food of the animal. Hence a systematic examination and delineation of the structure and arrangement of these organs, by the aid of the microscope and camera lucida, would be of the greatest service in this department of Natural History. The short thick tube of the *Limax* and other terrestrial Gasteropods appears adapted for the trituration of the food previously to its passing into the œsophagus; for in these animals we find the roof of the mouth furnished with a large strong horny plate, against which the flat end of the tongue can work. On the other hand, the flattened portion of the tongue of *Buccinum* and its allies is used by these animals as a file, with which they bore holes through the shells of the mollusks that serve as their prey. This they are enabled to effect by everting that part of the proboscis-shaped mouth whose floor is formed by the flattened part of the tongue, which is thus brought to the exterior, and by giving a kind of sawing motion to the organs by means of the alternate action of two pairs of muscles—a protractor and a retractor—which put forth and draw back a pair of cartilages whereon the tongue is supported, and also elevate and depress its teeth. Of the use of the long blind tubular part of the tongue in these Gasteropods, however, scarcely any probable guess can be made, unless it be a sort of "cavity of reserve," from which a new toothed surface may be continually supplied as the old one is worn away—somewhat as the front teeth of the rodents are constantly being regenerated from the surface of the pulps which occupy their hollow conical bases, as fast as they are rubbed down at their edges. The preparation of these tongues for the microscope can, of course, be only accomplished by carefully dissecting them from their attachments within the head; and it will be also necessary to remove the membrane that forms the sheath of the tube, when this is thick enough to interfere with its transparency. The tube itself should be slit up with a pair of fine scissors through its entire length, and should be so opened out that its expanded surface may be a continuation of that which forms the floor of the mouth. The mode of mounting it will depend upon the manner in which it is to be viewed. For the ordinary purposes of microscopic examination, no method is so good as mounting in fluid, either weak spirit or Goadby's solution answering very well. But many of these tongues, especially those of the marine Gasteropods, become most beautiful objects for the polariscope when they are mounted in Canada balsam—the form and arrangement of the teeth being very strongly brought out by it, and a gorgeous play of colours being exhibited when a selenite plate is placed behind the

object and the analyzing prism is made to rotate.

Bibl. Carpenter, *The Microscope*, pp. 606–610, whence the above description is taken; W. Thomson *in Todd's Cycl. Anat. & Phys.* iv. pp. 1142, 1143; *Ann. Nat. Hist.* ser. 2. vii. p. 86; Gray, *Ann. Nat. Hist.* ser. 2. x. p. 413; Macdonald, *Ann. Nat. Hist.* 1868, ii. p. 236, 1869, iii. p. 113; Mapleson, *Mo. Mic. Jn.* 1872, p. 45; Hogg, *Trans. Mic. Soc.* 1868.

TONSILS.—The surface of these organs is lobulated by fissures of various depths and complexity. Each tonsil is to be regarded as a thickened portion of the mucous membrane, presenting a lobulated surface, the proper membrana mucosa of which constitutes a kind of conglobate gland-substance (Henle), consisting partly of fibrous and partly of adenoid tissue, in the meshes of which numerous lymph-corpuscles are contained. The epithelium is here tessellated and laminated; papillæ can scarcely be said to be present. Beneath the epithelium is a close plexus of vessels; and the infiltrated mucosa is divided into portions resembling Peyer's patches by means of connective-tissue cords proceeding from the submucous tissue. Acinous glands are distributed in the submucous tissue, and they are in contact externally with the muscular tissue of the pharynx.

Bibl. Klein and Verson *in Stricker's Hum. & Comp. Hist.* vol. i.

TOPAZ.—The crystals of this mineral consist principally of silicate of alumina, with the fluorides of aluminium and silicium.

Sections of topaz often exhibit microscopic cavities, frequently containing crystals and one or two non-miscible liquids, the latter sometimes including bubbles of gas or vapour.

Brewster recommended the spherical cavities as the best objects for examining the aberrations of lenses.

Bibl. Brewster, *Edinb. Phil. Trans.* x. & xvi.; *Treat. on the Microscope*, p. 186.

TORQUATEL'LA, E. Ray Lankester.—A doubtful genus of Infusoria.

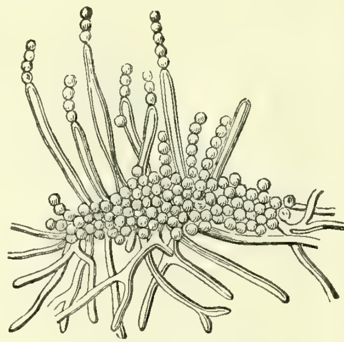
Char. Body oblong, rounded posteriorly and open anteriorly, where there is a frill of undulating membrane. There are no cilia, nor have vacuoles or nucleus been observed. Marine in Bay of Naples.

Bibl. E. Ray Lankester, *Qu. Mic. Jn.* 1874, p. 272.

TOR'TULA, Hedw. See Barbula.

TOR'ULA, Pers.—A genus of Torulacei. The plants ordinarily referred here appear to be somewhat heterogeneous in their nature. In what may be considered the true species, the chains of spores form the principal bulk of the plants, little or no filamentous mycelium existing. Other forms very generally included under this head agree in their characters with Oidium, which itself is a doubtful genus, probably founded on the conidiiferous states of more perfect kinds. But in *T. sacchari* (or *cerevisiæ*), the Yeast-fungus, usually referred here, we find both forms presented; for when actively vegetating in fermenting liquids, it presents the characters shown in fig. 23. Pl. 20, while, when the liquid becomes exhausted, portions of the fungus float to the top, and produce a filamentous structure, terminating in chains of "spores," such as are represented in fig. 24 (Pl. 20), and in fig. 756. The simply beaded form is taken as the type of a genus *Cryptococcus* by some authors, of whom a part consider it a Fungus,

Fig. 756.



Torula sacchari (aërial form).
Magnified 200 diameters.

another part (Kützing especially) an Alga. The same varieties of form occur in the Vinegar-plant; and in both cases *Penicillium glaucum* seems invariably to succeed to the preceding when kept at a moderate temperature. Thus between all these various forms, together with *Oidium lactis*, there appears to be a relation, not yet quite clearly made out, indicating that they probably represent different states of the same plant growing under different conditions of nutrition and temperature. Further remarks on this head are made under Yeast and Vinegar-plant. A growth similar to *T. sacchari* presents itself sometimes in decomposing urine (Pl. 20. fig. 7) from healthy

subjects; and indeed scarcely any decomposing animal or vegetable fluid, in which there exist fermentible elements, remains long free from *Torula*-like growths, if left exposed to the air (see FERMENTATION).

We find it impossible to give definite characters for the species that have been enumerated. *T. herbarum* may be named as a common form growing on decaying stems of plants; it forms at first erect greenish tufts, which afterward become blackish, ramify and form a black crust, the spores readily separating. *T. Sporendonema*, a form growing on decaying cheese, represents the *Sporendonema casei* of Desmazières. *T. Fumago* is now separated with other forms under the genus CAPNODIUM. *T. alternata* also is the type of the genus ALTERNARIA.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 359; *Ann. Nat. Hist.* i. p. 263, vi. p. 439; 2 ser. v. p. 460, xiii. p. 460; Fries, *Syst. Myc.* iii. p. 499; *Summa Veget.* p. 505; Fresenius, *Beitr. z. Myc.* Heft ii. p. 58, pl. 6. fig. 55; Corda, *Icones Fungorum.*

TORULA'CEI.—A family of Coniomycetous Fungi, forming moulds and mildews on decaying vegetable substances, or acting as ferments in decomposing vegetable and animal fluids. They are compound microscopic

Fig. 757.

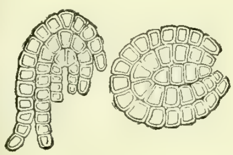


Fig. 759.

Fig. 758.

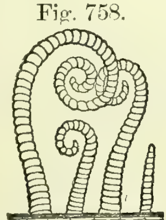


Fig. 757. Speira toruloides. Magnified 200 diameters.
Fig. 758. Gyrocerus ammonis. Magnified 200 diams.
Fig. 759. Trimmatostroma salicis. Magn. 200 diams.

cylindrical or beaded filaments, simple or ramified, the joints of which (all or part) separate from each other to form the "spores." There is no definite receptacle here; the mycelium grows as a cottony web over or in the infected body, or forms clouds or flocks in liquids. Much obscurity prevails respecting most of the genera included below, and it is indeed doubtful whether most of them are independent productions. Some species of *Torula*, such as *T. cerevisiæ*, (the Yeast-fungus), appear intimately connected with certain Hyphomycetous genera, perhaps merely representing their conidiiferous forms (see TORULA). ACHORION, again, seems to be merely the spermogonous form of a *Puccinia*. *Sporendonema* is founded apparently on imperfect observation; *S. muscæ*, the true characters of which are given under that head, has been renamed *Empusa*; and its proper position is as yet obscure; but it would appear to be referable to the Mucorini. *Dictyosporium* (fig. 172, p. 249), *Speira* (fig. 757), and *Trimmatostroma* (fig. 759) appear to consist merely of the spores of some other genera; *Gyrocerus* (fig. 758) cannot be regarded as a perfect form; and indeed all the genera require a thorough examination in a fresh state.

Synopsis of Genera.

1. *Torula.* Spores in beaded chains, simple, readily separating, placed on a short continuous or septate pedicel (fig. 756; Pl. 20. figs. 7 & 23).

2. *Bispora.* Resembling the last, but the spores uniseptate (fig. 60, p. 93).

3. *Septonema.* Resembling the preceding, but having several transverse septa in the spores (fig. 640, p. 696).

4. *Alternaria.* Resembling the preceding, but with cellular spores connected by a filiform isthmus (fig. 9, p. 31).

5. *Sporidesmium.* Spores in tufts, straight, subclavate or fusiform, shortly stalked or sessile, transversely septate or cellular (fig. 690, p. 737).

6. *Tetraploa.* Spores sessile, quadriseptate, coherent in bundles of four, each spore crowned with a bristle.

7. *Sporochisma.* "Filaments erect, simple, external membrane inarticulate, cell-contents at length separating into spores, articulated in fours, emerging."

8. *Coniothecium.* Spores without septa, collected in heaps, finally separating more or less into a powder.

9. *Echinobotryum.* Spores rounded-apiculate, collected in fascicles, attached on simple, erect, annulated filaments.

10. *Spilocæa.* Spores globose, simple, adhering firmly together and to the matrix, forming spots laid bare by the separation of the epidermis of the subject infected.

11. *Sporendonema.* Described as composed of erect filaments, containing single rows of spores in the interior. *S. muscæ* (*Empusa,* Cohn) really consists of short, tufted, erect, simple filaments, terminating in a bell-shaped cell (spore or sporange?), thrown off with elasticity when mature.

12. *Achorion.* Mycelium somewhat ramose, articulated, joints terminating in round, oval, or irregular spores (conidia?).

13. *Speira.* Spores connate into concentric filaments, forming laminæ resembling a horseshoe, finally separating.

14. *Trimmatostroma.* Spores more or less curved, multiseptate, chained in beaded rows, finally separating.

15. *Gyrocerus.* Spores connate into spirally coiled filaments, finally separating.

16. *Dictyosporium.* Spores tongue-shaped, reticularly cellular (fig. 172, p. 249).

TOURMALINE.—Sections of the crystals of this mineral, cut parallel to the axis, were formerly used as polarizers or analyzers. They are now mostly replaced by Nicol's prisms (INTRODUCTION, p. xviii). Crystals of the quinine-salt (QUININE) form cheap substitutes for either. The crystals of tourmaline belong to the rhombohedric system. They consist principally of silica with alumina, also containing boracic acid, magnesia, iron, &c.; but their composition is not constant.

Good tourmalines are transparent, brownish or pinkish: the colourless ones do not polarize.

BIBL. Pereira, *Lectures on Polarized Light*; Naumann, *Mineralogie*, p. 319.

TOUS-LES-MOIS. — A kind of fecula consisting of the starch of species of *Canna*, remarkable for the large size, great transparency, and numerous striæ of the granules (Pl. 37. fig. 25). The mixture of any of the common kinds of starch with *Tous-les-mois* is readily detected by microscopic examination. The granules are excellent subjects for studying the physical characters of starch, in particular the appearance with polarized light (Pl. 31. fig. 40), &c. See STARCH.

TOXONIDEA, Donkin. — A proposed new genus of Diatomaceæ, the frustules of which resemble those of *Gyrosigma*, except that the longitudinal line is curved on each side of the median nodule in the same direction, so as to resemble a bow. Two species.

T. Gregoriana (Pl. 42. fig. 42).

BIBL. Donkin, *Micr. Jn.* 1858, vi. p. 12; Rabenht. *Fl. Eur. Alg.* i. p. 243.

TRACHEA. See LUNGS.

TRA'CHEÆ OF INSECTS, &c.—The respiratory tubes of Insects and Arachnida (ARACHNIDA).

Tracheæ (Pl. 27. fig. 17; Pl. 28. fig. 2 *h*) are cylindrical tubes containing air. They are broadest at their origin from the spiracles, afterwards branching freely, the minute branches being distributed to all parts of the body and anastomosing freely. By reflected light they appear white, with a metallic lustre, or slightly iridescent; by transmitted light the smaller ones are black, the larger usually of a violet tint.

The tracheæ consist of two coats, between which lies a spiral fibre (Pl. 27. fig. 17); in the larger trunks a second external envelope exists. The fibre becomes more slender and indistinct in the smaller tracheal branches, until it finally disappears. The outer membrane appears to arise from the confluence of cells; for in the tracheæ of caterpillars and other larvæ of insects, the remaining nuclei are visible (Pl. 28. fig. 17). The inner coat forms a pavement epithelium. The spiral fibre arises from the splitting up of a homogeneous membrane deposited in the space bounded by the confluent cells of the outer membrane.

In many insects the tracheæ are furnished with dilatations forming air-sacs, in which the spiral fibre is absent.

When larvæ are fed with indigo or carmine, or when the dorsal vessel is injected with colouring-matter, the tracheæ become coloured, which some authors believe to arise from the nutritive liquid circulating between the membranes of the tracheæ; whilst by others this circulation, or the existence of a space between the tracheal membranes, is denied.

BIBL. That of INSECTS; Newport, *Phil. Trans.* 1836, p. 529; Platner, *Müller's Archiv*, 1844, xxxviii.; Stein, *Vergleich. Anat. d. Insekten*; Agassiz, *Ann. des Sc. Nat.* 3 sér. xv.; Bassy, *ibid.*; Joly, *ibid.* xii.; Blanchard, *Compt. Rend.* 1851, or *Ann. Nat. Hist.* 1852, ix. 74; Dufour, *Compt. Rend.* 1851, or *Ann. Nat. Hist.* 1852, ix. 435; Meyer, *Siebold & Kölliker's Zeitschr.* i. 175; Moseley, *Proc. Roy. Soc.* No. 153. vol. xxii. p. 344, 1874; Gerstäcker, *Siebold & Kölliker's Zeitschr.* ii. p. 204, 1874; Landois, *Zeit. f. wiss. Zool.* xvii.

TRACHEÆ OF PLANTS. — This name was formerly applied to the unrollable SPIRAL Vessels of Plants, from their resemblance to the tracheæ of Insects.

TRACHELI'NA.—A family of Infusoria Ciliata. See p. 410.

Char. Body without regular spiral teeth and foot. Parenchyma excessively contractile. Body ciliated, mouth and œsophagus very dilatable.

Synopsis of Genera.

TRACHELINA.	Mouth terminal.	Anterior part of body with a conical appendage.	Body more or less cylindrical, moving by turning on axis.	Mouth on the summit of the appendage ...	1. *Lachrymaria.*
				Mouth at the base of it	2. *Phialina.*
			Body flat. Swims without turning on axis		3. *Trachelophyllum.*
		No conical appendage.	No internal teeth. No leaping cirri.	Body attenuate in front	4. *Enchelys.*
				Body not attenuate in front	5. *Holophrya.*
			No internal teeth. Leaping cirri		6. *Urotricha.*
			Internal teeth	Body attenuate in front	7. *Euchelyodon.*
				Body not attenuate in front	8. *Prorodon.*
	Mouth not terminal.	Œsophageal teeth present.	No cirri ...	Body never much flattened............	9. *Nassula.*
				Body much flattened......................	10. *Chilodon.*
			A bundle of cirri, simulating a foot		11. *Trichopus.*
		No œsophageal teeth.	A row of spherical vesicles, each enclosing a very refractive body		12. *Loxodes.*
			No vesicles. No lateral lamina.	A branched intestine...	13. *Trachelius.*
				No branched intestines	14. *Amphileptus.*
			No vesicles. A broad marginal lamina of compact tissue		15. *Loxophyllum.*

BIBL. Clap. et Lachm. *Etudes*, p. 294.

TRACHE'LIUS, Clap. et Lach. (Ehrenb., amended).—A genus of Trachelina (Ciliate Infusoria).

Char. Mouth situated at the base of the trunk-like prolongation, alimentary canal ramified, which opens at the posterior extremity of the body as the anus. No row of spherical vesicles or lateral lamina. See Synopsis of *Trachelina.*

Thus limited there is only one species, *T. ovum*, the *Amphileptus ovum* of Dujardin. *Trachelius lamella* (Pl. 25. fig. 5) is a *Loxophyllum.*

BIBL. Clap. et Lachm. *Etudes*, p. 345.

TRACHELOCER'CA, Ehr.—A genus of Infusoria = *Lacrymaria.*

T. olor = *Lacrymaria olor* (p. 441).

T. viridis (Pl. 24. fig. 33). Body green; neck as in the last. Aquatic; length 1-120''.

BIBL. Ehr. *Infus.* p. 341; Clap. et Lach. *Etudes*, p. 295.

TRACHELOM'ONAS, Ehr.—A genus of Infusoria, of the family Cryptomonadina.

Char. Body enclosed in a spherical or ovoid hard and brittle envelope, having a small aperture, from which a long flagelliform filament projects, but no neck (?); eye-spot present.

1. *T. volvocina* (Pl. 23. fig. 24 *d*, empty envelope). Spherical, green, brownish, or red; eye-spot red. Aquatic; length 1-865''.

2. *T. nigricans.* Ovate-globose, green, blackish brown or reddish; eye-spot brownish. Aquatic; length 1-1730''.

3. *T. cylindrica.* Oblong-subcylindrical; bright green; eye-spot red. Aquatic; length 1-1000''.

The bodies represented in Pl. 23. fig. 24 (*b* to *g*), and which are commonly found in bog-water, probably belong here, with the genera *Chætoglena* (*a*), *Chætotyphla* (fig. 26), and *Doxococcus* (fig. 47). The margins of the red envelope appear as a bright red ring, on account of the greater thickness traversed by the light. They are probably spores of Algæ.

BIBL. Ehrenberg, *Infus.* p. 47.

TRACHELOPHYL'LUM, Clap. et Lach.—A genus of Trachelina (Infusoria Ciliata).

Char. Anterior part of the body with a prolonged appendage, which has no circlet of cirri. Body flat, without a lateral marginal lobe. Swims without turning on its axis. Two species:

Trachelophyllum apiculatum = *Trachelius apiculatus*, Perty.

T. pusillum.

BIBL. Clap. et Lachm. *Etudes*, p. 306.

TRACHYLIA, Fr.—A genus of Microlichens, parasitic on *Pertusariæ.*

Char. Thallus granulose; apothecia capuliform, sessile, black. Spores nigricant, 1-septate.

BIBL. Lindsay, *Qu. Mic. Jn.* 1869, p. 146; Leighton, *Brit. Lich. Flor.* p. 48.

TRADESCAN'TIA, L. — A genus of Commelynaceæ (Monocotyledons), commonly cultivated in gardens under the name of 'Spider-worts.' These plants are celebrated for having served as material for some of the most remarkable observations on the physiological processes of vegetables —as the ROTATION of the cell-contents, and the multiplication of the cells, so well seen in the hairs of the stamens when young

(Pl. 38. figs. 8 & 9). The stems, petioles, &c. afford beautiful spiral, annular, and reticulated vessels, &c.

TRE'BIUS, Kröyer.—A genus of Crustacea, of the order Siphonostoma, and family Caligidæ.

Char. Head in the form of a large buckler, with the large frontal plates destitute of sucking disks; thorax three-jointed, segments uncovered; legs four pairs, with long plumose hairs, fourth pair slender, and two branched; antennæ small, flat, and two-jointed; second pair of foot-jaws two-jointed, and not in the form of a sucking disk.

T. caudatus. Found upon the body of the skate. Male much smaller than the female.

Bibl. Baird, *British Entomostraca*, p. 280; Thompson, *Ann. Nat. Hist.* 1847, xx. 248.

TREMATO'DA.—An order of Annuloida, class Scolecida.

These are parasitic flat worms or flukes. See Distoma.

Bibl. Huxley, *Elem. Comp. Anat.*

TREMELLI'NI.—A family of Hymenomycetous Fungi, consisting of polymorphous, often convoluted or lobed, more or less gelatinous masses, growing upon branches or stumps of trees, in crevices of the bark, or on the dead wood. The hymenium extends over the whole of the upper exposed surface, and, from the recent researches of Tulasne, appears to present remarkable characters. The gelatinous substance of these Fungi is composed of ramified filaments, with more or less effused mucilage between them. In *Tremella* a portion of the filaments terminate at the surface at first in expanded globular cells, which become divided by vertical septa into four somewhat pyriform cells (*basidia*); from each of these arises a slender filament (*sterigma*), which terminates in a slender point tipped with a globular spore (*stylospore* or *basidiospore*). Other filaments coming to the surface in like manner ramify extensively, with short divergent branches, finally bearing numerous minute globular bodies (*spermatia*), solitary or in groups of four, which, like the basidiospores, fall off and rest on the hymenial surface, involved in jelly, but, unlike those, do not germinate. The basidiospores are about 1-3000″ in diameter, the spermatia about 1-12000″. In *Tremella mesenterica* the surface covered with basidiospores assumes a whitish colour, the layers of spermatia and the jelly are orange.

In *Exidia* the production of the basidiospores is similar; but the spores are reniform and unilocular, about 1-2500″ long and 1-5000″ in diameter. Spermatia have not been detected.

In *Dacrymyces* the basidia are represented by simple clavate or bifurcated branches at the hymenial surface, these terminating in points bearing single reniform spores exhibiting three septa (quadrilocular). In germination some of these spores produce a long filament from each loculus; others behave differently, producing the *spermatia* of the plant, each loculus sending out a short pointed process bearing a globular cellule exactly resembling the spermatia of *Tremella.* Other examples of *Dacrymyces* bear a different kind of reproductive body, apparently representing *conidia.* In these the peripheral filaments terminate in a mass of many-jointed *Torula*-like processes, which ultimately break up into the separate joints. (See Dacrymyces and Exidia.)

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 215; *Ann. Nat. Hist.* 2 ser. xiii. p. 406, pl. 15. fig. 4; Tulasne, *Ann. des Sc. Nat.* 3 sér. xix. p. 193, pls. 10–12.

TREPOM'ONAS, Duj.—A genus of Infusoria, of the family Monadina.

Char. Body compressed, thicker and rounded behind, twisted in front into two narrowed lobes, which are inflexed laterally, and each terminated by a flagelliform filament, which produces a very lively rotatory and jerking motion.

T. agilis (Pl. 25. fig. 6). Body granular, unequal. Length 1-1160″. Found in decomposing marsh-water.

Bibl. Dujardin, *Infus.* p. 294.

TRIAR'THRA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes two, frontal; foot simply styliform; body with lateral cirri or fins.

Movement jerking. Jaws two; each bidentate.

1. *T. longiseta* (Pl. 35. fig. 30). Eyes distant, cirri and foot nearly three times as long as the body. Aquatic; length 1-216″.

2. *T. mystacina.* Eyes approximate; cirri and foot scarcely twice as long as the body.

3. *T. breviseta* (Gosse). Cirri much shorter than the body.

Bibl. Ehr. *Infus.* p. 446 Gosse, *Ann. Nat. Hist.* 1851, viii. p. 200; Pritchard, *Infus.*

TRICERA'TIUM, Ehr.—A genus of Diatomaceæ.

Char. Frustules free; valves triangular, areolar, each angle mostly with a minute tooth or short horn.

T. favus (Pl. 13. fig. 29). Valves plane or convex, angles obtuse, with horn-like processes; areolæ hexagonal. Marine; diameter 1-240″.

BIBL. Ehr. *Ber. der Berl. Akad.* 1840; Smith, *Brit. Diatomaceæ,* i. p. 26; Kütz. *Bacill.* p. 138, and *Sp. Alg.* p. 139; Brightwell, *Micr. Journ.* 1858, p. 153; Rabenht. *Fl. Eur. Alg.* i. p. 315.

TRIC'HIA, Hall.—A genus of Myxogastres (Gasteromycetous Fungi) growing upon rotten wood &c., characterized by a stalked or sessile, simple, membranous peridium, which bursts at the summit, whence the densely interwoven free capillitium expands elastically, carrying with it the spores. The capillitium is composed of tubular filaments (*elaters*), containing spiral-fibrous secondary deposits, like the elaters of *Marchantia* (Pl. 32 fig. 39). In some species the elaters bear numerous little spinulose processes. The genus is divisible into two groups. In the first (*Hemiarcyria*) the dehiscence of the peridium is obscurely circumscissile (fig. 760), the capillitium dense; these are always stalked, usually of reddish colour when young. Some species have the peridia fasciculate on a compound peduncle (fig. 760), others separate. In the other division (*Goniospora*) the dehiscence of the peridium is irregular, the capillitium lax, the peduncle short or

Fig. 760.

Trichia rubiformis.
Magnified 25 diameters.

absent, the colour at first whitish, changing to yellow and the spores rather angular. In *T. serpula* and *reticulata* the sessile peridia are irregular, flexuous, serpentine or annular bodies; in most of the other species the peridia are pyriform, turbinate, or of some analogous form. The elaters (Pl. 32. figs. 39 & 40) are interesting objects, and form good tests for the defining-power of the microscope under very high powers. They must be mounted in a very thin stratum of liquid.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 319; *Ann. Nat. Hist.* vi. p. 432, 2 ser. v. p. 367; Fries, *Syst. Myc.* iii. p. 182; *Summa Veg.* 457; Greville, *Sc. Crypt. Fl.* pls. 266, 281; Henfrey, *Linnean Trans.* xxi. p. 221; Currey, *Microsc. Journ.* iii. p. 15, v. p. 127.

TRIC'HINA, Owen.—A genus of Entozoa, of the order Cœlelmintha and family Nematoidea.

T. spiralis (Pl. 16. figs. 16, 17, 18) inhabits the human body, forming opaque white specks, visible to the naked eye, in the voluntary muscles. The worms usually exist singly within a cyst situated between the muscular bundles (fig. 16). At each end of the cyst is a group of fat-cells resembling those of ordinary fatty tissues. The cysts are about 1-50″ in length, elliptical or oval, usually narrowed and slightly produced at the obtuse ends, and consist of numerous structureless laminæ, in which are frequently imbedded minute granules consisting of fatty or calcareous matter. The worm is cylindrical, narrowed towards the anterior end, the posterior end being obtuse and rounded. The integument is transversely striated or annular, and exhibits an anterior and a posterior longitudinal muscular band. The mouth (fig. 17 *a*) is situated at the anterior extremity, from which a small papilla is sometimes protruded. The first part of the alimentary canal is very narrow, and leads to a broader sacculated portion; this behind the commencement of the posterior half of the body terminates in a funnel-shaped expansion (fig. 18 *c*), the remainder of the canal being narrow and lined with pavement-epithelium (fig. 18 *d*). The manner in which the posterior end of the alimentary canal terminates is doubtful—whether directly continuous with the anal orifice, or free in the abdominal cavity. M. Luschka describes three valves as existing at the posterior end of the body. At the commencement of the funnel-shaped portion of the alimentary canal (fig. 16 *b*) are two rounded glandular sacs. The reproductive organs are not well known. Just below the funnel-shaped portion of the alimentary canal is the

cæcal origin of a tubular sac (fig. 17 & 18 *c*), containing a dark granular-looking body (fig. 17 *d*; fig. 18 *e*) near its commencement; this extends to the posterior end of the worm, where it either terminates in the anus or in the abdominal cavity. Luschka regards this as the male organ, and the dark-looking body as the testis; but no spermatozoa have been detected.

Some of the cysts and worms are found in a state of fatty degeneration, with granules or globules of fat, and calcareous matter.

It appears that the *Trichina* of man is derived from the food. The *Trichina* is known in two different conditions. In one it is sexually immature; and it then inhabits the muscles of the pig, for instance, in vast numbers, each worm being coiled up in its capsule or cyst. It is incapable of further development under these circumstances, But if a portion of the muscle be eaten by a warm-blooded vertebrate animal and so introduced into the alimentary canal, the immediate development of young *Trichinæ* is the result. The immature worms escape from the cysts, grow larger, develop sexual organs, and produce viviparously a numerous progeny. The young *Trichinæ* thus produced perforate the walls of the digestive system, and after working into the muscles become encysted.

Three or four other doubtful species have been described.

Bibl. Owen, *Trans. of Zool. Soc.* i. p. 315; Luschka, *Siebold & Kölliker's Zeitschr.* iii. 69; Bristowe and Rainey, *Trans. Path. Soc.* v. 274; Duj. *Hist. Nat. d. Helminthes*, p. 293; Herbst, *Ann. des Sc. Nat.* 3 sér. xvii.; Kobelt, *Valentin's Repertorium*, 1841; Leuckart, *Unters. ü. Trichina*; Bakody, *Sieb. u. Köll. Zeit.* 1872, p. 422; Virchow, *Qu. Mic. Jn.* 1861, p. 44; Cobbold, *Entozoa & Domes. Parasit.*, and Pagenstecker *quoted therein*, p. 121.

TRICHOCEPH'ALUS, Goeze.—A genus of Entozoa, of the order Cœlelmintha, and family Nematoidea.

Char. Body elongate, composed of two parts, the anterior longer and capillary, the posterior becoming suddenly broader; spiculum of male simple, long, and surrounded by a sheath.

The species occur in the large intestine, principally the cæcum of man and the mammalia.

T. dispar (Pl. 16. fig. 19, the male; fig. 21, the female, in which the narrowed portion is too short).

Anterior portion of the body spiral in the male, containing the œsophagus only, or the first moniliform portion of the intestine; posterior portion containing the rest of the intestine and the reproductive organs. Anus situated at the posterior obtuse end of the body. Integument transversely striated, and with a longitudinal band studded with papillæ (Pl. 16. fig. 20). Oviduct terminating at the point of junction of the two portions of the body; ova (fig. 21 *a*) oblong, covered by a resistant shell, with a short neck at each end.

Bibl. Dujardin, *Helminthes*, p. 30; Owen, *Todd's Cycl. Anat. & Phys.* art. *Entozoa*; Wedl, *Pathol. Histolog.* p. 787; Leuckart, *Qu. Mic. Jn.* viii. p. 168.

TRICHOCOLE'A, Nees.—A genus of Jungermannieæ (Hepaticæ), containing one British species, *T. (Jung.) tomentella*, growing in moist places in the west and north of England, Scotland, and Ireland. It is remarkable for the character of the leaves, which are cut up into compound capillary segments, giving the plant a spongy texture. Colour pale.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 127; *Brit. Jung.* pl. 36; Eckart, *Synops. Jung.* pl. 6. fig. 49; Endlicher, *Gen. Plant.* Supp. 1. no. 472, p. 15.

TRI'CHOCYSTS. See Infusoria, p. 401.

TRICHO'DA, Müll., Ehr.—A doubtful genus of Infusoria.

T. angulata (Pl. 25. fig. 7). Body oblong, obliquely and irregularly folded or angular, frequently with one or more superficial vacuoles. Aquatic; length 1-900''.

T. pyrum, D. = *Leucophrys carnium*, E.

Bibl. Ehr. *Infus.* p. 306; Duj. *Infus.* p. 395.

TRICHODAC'TYLUS, Dufour.—A genus of Arachnida, of the order Acarina, and family Acarea.

Bibl. Dufour, *Ann. des Sc. Nat.* 2 sér. xi. p. 276; Gervais, *Walckenaer's Aptères*, iii. p. 266.

TRICHODEC'TES, Nitzsch.—A genus of Anoplurous Insects, of the family Philopteridæ.

Char. Antennæ filiform, three-jointed; maxillary palpi none or inconspicuous; mandibles two-toothed; tarsi with one claw.

T. latus (Pl. 28. fig. 6). Abdomen pale fulvous; head and thorax ferruginous yellow; head subquadrate, with two black spots in front, and a black lateral band on each side; abdomen oval.

Common upon dogs, especially puppies.

BIBL. Denny, *Anoplur. Monograph*, p. 186.

TRICHODER'MA, Pers.—A genus of Fungi placed by Fries among the Gasteromycetes. The plants are characterized by a roundish peridium composed of interwoven, ramified, septate filaments, evanescent at the summit; the spores minute, heaped together, at first conglobated. *T. viride*, growing on fallen trees, has a white villous peridium, and dusky-green globose spores. The peridia appear as scattered spots 1-20 to 1-8″ or more in diameter. It is a conidiiferous state of *Hypocrea rufa*.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 323; Greville, *Sc. Crypt. Fl.* pl. 271; Fries, *Summa Veg.* p. 417.

TRICHODES'MIUM, Ehrenb.—A genus of microscopic Algæ, apparently belonging to the Nostochaceæ, discovered by Ehrenberg to produce the red colour over large tracts in the Red Sea, and found also in the Atlantic and Pacific Oceans by Darwin and Hinds, and in the Chinese Sea. No vesicular cells or spermatic cells have been detected; hence the characters are as yet imperfect. Montagne has separated the plant of Hinds from Ehrenberg's; and Kützing characterizes the two species in his *Sp. Algarum*, and figures them in his *Tabulæ Phycologicæ*; but neither the figures nor the descriptions indicate any very marked differences.

T. Ehrenbergii, Montagne. Blood-red (at length becoming green); bundles widish, confluent; filaments 1-3000″ in diameter, joints about twice as wide as long. Found floating in vast strata in the Red Sea by Ehrenberg and Dupont, and in the Yellow Sea (China) by Mollien, Bellot, and others.

For further information on the species, and on the red coloration of the sea by plants, see Montagne's papers in the *Annales des Sc. Naturelles*, 3 sér. ii. p. 332, vi. p. 262; 4 sér. i. p. 81; *Ann. Nat. Hist.* 2 ser. xix. p. 431; Rabenht. *Fl. Eur. Alg.* ii. p. 161.

TRICHODI'NA, Ehr.—A genus of Infusoria, of the family Vorticellina.

Char. No tail, nor pedicle; cilia absent from the surface of the conical or discoidal body, but forming a frontal crown or a tuft; oral orifice not spiral.

1. *T. pediculus* (*Urceolaria stellina*, D.) (Pl. 24. fig. 16). Body discoidal, the under and upper surfaces each with a crown of cilia.

Parasitic upon *Hydra vulgaris* and *viridis*. Breadth 1-575 to 1-290″. On the under surface is an annular undulatory membrane; and within and at the base of this is a horny ring, with an outer and inner row of teeth, forming an organ of adhesion.

2. *T. mitra*. Parasitic upon *Planaria torva*.

3. *T. grandinella* and *T. vorax* on Halterina.

4. *T. tentaculata*. Body discoidal, cilia large, forming a tuft; a styliform, tentacle-like process present. Aquatic; diameter 1-290″.

BIBL. Ehrenberg, *Infus.* p. 265; Dujardin, *Infus.* p. 527; Siebold, *Vergl. Anat.* p. 12; *Siebold und Kölliker's Zeitschr.* ii. p. 361; Stein, *Infus.* p. 174; Claparède et Lachmann, *Etudes*, p. 128.

TRICHODINOP'SIS, Clap. et Lach.—A genus of Ciliate Infusoria, the position of which in the classification is doubtful.

Char. Resembles externally one of the Vorticellina, but it is covered with well-developed cilia. The species, *T. paradoxus*, inhabits in myriads the intestines of *Cyclostoma elegans*.

BIBL. Claparède et Lachmann, *Etudes*, p. 152.

TRICHODIS'CUS, Ehr.—A genus of Rhizopoda, family Actinophryina, D.

Char. Body depressed, stalkless; setaceous tentacles forming a simple row at the margin of the body.

T. sol (Pl. 25. fig. 8). Body suborbicular, hyaline or yellowish, tentacles variable. Aquatic; diameter 1-432 to 1-216″.

BIBL. Ehr. *Infus.* p. 304.

TRICHOGAS'TRES (*Puff-balls*).—A family of Gasteromycetous Fungi, characterized by the contents of the leathery peridium breaking up when mature into a pulverulent mass of spores and filaments, without a central column, the whole being expelled by the bursting of the case (see GASTEROMYCETES).

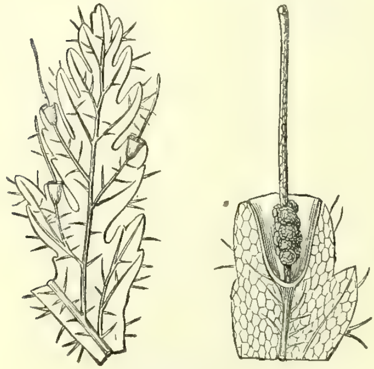
BIBL. Berkeley, *Ann. Nat. Hist.* iv. p. 155; Tulasne, L. R. and C., *Ann. des Sc. Nat.* 2 sér. xvii. p. 1.

TRICHOLO'MA, Fr.—A subgenus of *Agaricus* belonging to the white-spored series, characterized by the gills being sinuated behind. *A. gambosus* is an excellent article of food, appearing in rings about the end of April or beginning of May.

BIBL. Fr. *Syst. Myc.* i. p. 36; Berk. *Outl.* p. 97; Sow. t. 281; Hass. i. t. 83; Cooke, *Handb.* p. 20.

TRICHOM'ANES, Linn.—A genus of Hymenophyllaceous Ferns, of elegant and delicate habit.

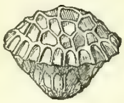
Fig. 761. Fig. 762.



Trichomanes alatum.

Fig. 761. A pinnule. Magnified 5 diameters.
Fig. 762. Section through a sorus, showing the vein prolonged as a columella, and continued out beyond the border. Magnified 25 diameters.

Fig. 763.



A sporange, with horizontal annulus. Magnified 100 diameters.

TRICHOM'ONAS, Duj.—A genus of Infusoria, of the family Monadina.

Char. Body ovoid or globular, becoming drawn out when adherent to the slide, hence sometimes exhibiting a tail-like prolongation; an anterior flagelliform filament present, with a group or row of vibratile cilia.

1. *T. vaginalis* (Pl. 25. fig. 9). Body glutinous, nodular, unequal, frequently becoming agglutinated to other objects; movement vacillating. Length 1-2500″. Found in morbid vaginal mucus.

2. *T. limacis* (Pl. 25. fig. 10). Body ovoid, smooth, pointed at each end; movement forwards, by revolution upon its axis. Length 1-1600″. Found in the intestine of *Limax agrestis.*

Bibl. Dujardin, *Infus.* p. 299.

TRICHOPH'RYA, Clap. et Lach.—A genus of Acinetina.

Char. Body fixed on to objects without a peduncle, no sheath, suckers not branched but disseminated in groups over the surface. Contractile vesicles numerous, nucleus band-like.

One species, *T. epistylidis*, parasitic on *Epistylis plicatilis.*

Bibl. Claparède et Lachmann, *Etudes*, p. 386.

TRIC'HOPUS, Clap. et Lach.—A genus of Trichodina (Ciliate Infusoria).

Char. Body depressed, and furnished with a bundle of long cirri, which is implanted on the ventral side near the posterior extremity of the body.

One species, *T. dysteria,* from the sea at Bergen.

Bibl. Claparède et Lachmann, *Etudes*, p. 338.

TRICHOR'MUS (*Anabæna*, Bory, Brébisson, Kützing, Montagne, &c.).—A genus of Nostochaceæ (Confervoid Algæ), growing on wet earth, or rising to the surface of lakes, brackish ditches, &c., forming an indeterminate stratum, at first nearly colourless and transparent, with the filaments sparingly scattered through the mass; the filaments afterwards increasing rapidly in number, causing the mass to become opaque, deep bluish green, and occasionally mottled with brown, especially beneath. The filaments are mostly short, moniliform, and frequently as much curved as in *Nostoc.* The cells are more or less globular; and the spermatic cells resemble the ordinary cells more in this than in the allied genera. The filaments closely resemble those of *Nostoc*; and some of the floating aquatic species can only be distinguished from that genus by the absence of definite form or size, and of the hardened periderm. It differs from *Dolichospermum* in the globular shape of its sporangia, and from *Sphærozyga* and *Cylindrospermum* in the arrangement of its vesicular and spermatic cells, which are in *Trichormus* separated by ordinary cells. In Pl. 4. fig. 2, we have represented what appears to be a new species.

Bibl. Ralfs, *Ann. Nat. Hist.* 2 ser. vol. v. pl. 8; Rabenht. *Fl. Eur. Alg.* ii. 293.

TRICHOSPO'RIUM, Fr.—A genus of Mucedines (Hyphomycetous Fungi), nearly allied to Botrytis, characterized by a cæspitose mycelium, whence arise fertile continuous filaments, bearing solitary, simple, acrogenous spores. *T. nigrum* = *Sporotrichum nigrum*, Fries (*Syst. Myc.*), *Botrytis nigra*, Link.

Bibl. Fries, *Summa Veg.* p. 492; Grev. *Sc. Crypt. Fl.* pl. 274.

TRICHOS'TOMUM, Hedw.—A genus of Pottiaceous Mosses, so called from the hair-like peristome, resembling closely that of Barbula (*Tortula*), but with the teeth straight instead of twisted; in *T. rigidulum*,

however (fig. 764), there exists a slight curling even in this genus. The *Trichostoma* grow on the ground and on stones.

Fig. 764.

Trichostomum rigidulum. Fragment of the peristome with filiform teeth. Magnified 100 diameters.

TRICHOTHE'CIUM, Link. (*Diplosporium* ejusd.). — A genus of Mucedines (Hyphomycetous Fungi), growing upon dead sticks, herbaceous parts of plants, &c., forming a cæspitose entangled mycelium, from which arise erect fertile filaments, bearing at the summit a few acrogenous, free, didymous spores. From some observations recently published by Hoffmann, and confirmed by Bail, the spores of *T. roseum*, when they germinate, produce a mycelium whence arise fertile filaments of *Verticillium ruberrimum*, the "spores" of which they consequently consider to be the *spermatia* of this plant. Several species are British, as *T. roseum, obovatum* (*Dactylium*, Berk.).

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 348; *Ann. Nat. Hist.* vi. p. 437, pl. 14; Greville, *Sc. Crypt. Fl.* pl. 172; Fries, *Summa Veg.* p. 492; Hoffmann, *Botan. Zeit.* xii. p. 249 (1854); Bail, *ibid.* xiii. p. 673 (1855).

TRICHY'DRA, Wright.—A genus of Hydroida of doubtful position in the classification.

Char. Stem creeping, branched; hydrothecæ rudimentary, consisting of very short tubular processes given off at intervals from the creeping stem; polypites cylindrical, very slender and extensile, with a short conical proboscis. Reproduction unknown.

Bibl. Hincks, *Brit. Hyd. Zooph.* p. 215.

TRILOCULI'NA, D'Orb.—A subgenus of *Miliola*, with the chambers aggregated on three opposite faces, embracing, three only apparent.

Many species, both recent and fossil. *M.* (*Tr.*) *trigonula* (Pl. 18. fig. 4).

Bibl. Williamson, *Rec. Brit. For.* p. 84 (*Miliolina*); Carpenter, *Introd. For.* p. 78.

TRINA'CRIA, Heib.—A genus of Diatomaceæ.

Char. Frustules with three broad, bispined, equal-lengthed processes, margin pearly, angles naked. Danube.

Bibl. Rabenht. *Fl. Eur. Alg.* i. p. 317.

TRINE'MA, Duj.—A genus of Rhizopoda, family Actinophryina.

Char. Carapace membranous, diaphanous elongate-ovoid, narrower in front, with a large oblique lateral orifice; expansions two or three, filiform, very slender, as long as the carapace.

T. acinus = *Difflugia enchelys*, E. (Pl. 25. fig. 11, after Ehr. In Dujardin's figure the expansions are represented as much more slender). Aquatic.

Bibl. Duj. *Infus.* p. 249; Clap. et Lach. *Etudes*, p. 455.

TRIOPHTHAL'MUS, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes three, red, cervical, in a transverse row; foot forked.

Jaws single-toothed.

T. dorsalis (Pl. 35. fig. 31). Body crystalline, turgid, suddenly attenuated at the foot, which is half the length of the body. Aquatic; length 1-48 to 1-36".

Bibl. Ehrenberg, *Infus.* p. 450; Pritchard, *Infus.*

TRIPHRAG'MIUM, Link.—A genus of Uredinei (Coniomycetous Fungi), distinguished by their trilocular spores (fig. 765). *T. ulmariæ* (*Uredo ulmariæ*, *Brit. Fl.*), grows upon the leaves of *Spiræa ulmaria*, forming orange, subsequently blackish, effused patches, bursting from beneath the epidermis. Tulasne has shown that it possesses all three forms of reproductive structure of the Uredinei, viz. 1. spermogonia with *spermatia*; 2. *Uredo*-fruits, with ellipsoid or globose *stylospores*; and 3. perfect fruits, arising either among the stylospores or in special sori containing stipitate, three-lobed spores (fig. 765), each lobe of which is unilocular and exhibits a single pore in its black tubercular outer coat. The last germinate in the spring, and produce from each pore a tubular filament which becomes divided into four or five chambers, from three or four of which arise single styliform processes (*sterigmata*), each bearing a small smooth spherical "sporidium." The globular stylospores also germinate (in the first summer), but produce only a long filiform process, probably the rudiment of a new mycelium. (See Uredinei.)

Fig. 765.

Triphragmium ulmariæ. A pedicellate spore. Magnified 350 diameters.

Bibl. Berk. *Brit. Fl.* ii. pt. 2. p. 368; Tulasne, *Ann. des Sc. Nat.* 4 sér. ii. p. 181, pl. 10; Fries, *Summa Veg.* p. 513; Currey, *Micr. Journal*, v. p. 126.

TRIPOSPO'RIUM, Corda.—A genus of Dematiei (Hyphomycetous Fungi), characterized by the three-lobed septate spores. *T.*

Fig. 766.

Triposporium elegans.
Magnified 200 diameters.

elegans (fig. 766) has been found in this country on bare oak-trunks. Another species, *T. Gardneri*, forms a blight in the coffee plantations of Ceylon.

BIBL. Berk. *Ann. Nat. Hist.* 2 ser. vii. p. 98; *Hortic. Journal*, iv. p. 8.

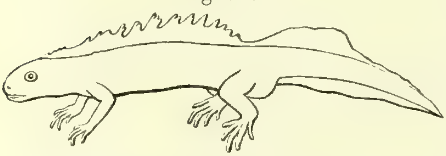
TRITAX'IA, Reuss. See TEXTULARIA.

BIBL. Reuss, *Sitzungs. Ak. Wien*, xliv. 383.

TRI'TON, Laur. (water-newts).—A genus of Reptiles.

If a male and female *T. cristatus* (fig. 767),

Fig. 767.



one of the common water-newts, be kept in a glass jar with healthy water-plants, they will lay their eggs upon them. The larvæ are very beautiful microscopic objects for showing the circulation in the gills and tail, the chorda dorsalis and the embryonic tissues; they should be kept in a vessel separate from the parents; otherwise these will devour them.

The injected skin of *T. palustris*, the large water-newt, forms a beautiful opaque object, showing the loose capillary network, which contrasts well with the brilliantly mottled skin.

BIBL. Bell, *British Reptiles.*

TROCHAM'MINA, Parker and Jones.—A variable genus of Arenaceous Foraminifera, very near *Lituola*; shell opaque, sandy, smooth; moniliform, serpentine, folded, discoidal, or subnautiloid and rotalioid; segmentation mostly obsolete except in the last. Very many species or varieties, recent and fossil. *Tr. incerta*, Pl. 18. fig. 14.

BIBL. Parker and Jones, *Q. J. Geol. Soc.* xvi. 304; *Ann. N. H.* 4, iv. 386; Carpenter, *Introd. For.* p. 141.

TROCHIL'IA, Duj.—A doubtful genus of Infusoria, of the family Ervilina.

Char. Body irregularly oval, narrower in front, where there are some vibratile cilia; carapace obliquely furrowed, slightly twisted, and terminated behind by a movable pedicle; no distinct mouth.

T. sigmoides (Pl. 25. figs. 12 & 13).

Fig. 12 represents the animal undergoing transverse division.

TROMBIDI'NA.—A family of Arachnida, of the order Acarina.

TROMBID'IUM, Latr. — A genus of Arachnida, of the family Trombidina.

Char. Palpi large, free; mandibles unguiculate; body turgid, bearing the four posterior legs, and an anterior narrow movable prominence, upon which the eyes, the four anterior legs, and the mouth are situated; anterior legs longest.

The species are numerous and not well characterized.

1. *T. phalangii* (Pl. 2. fig. 37). Body subtriangular, angles obtuse; of a velvety appearance, from the presence of numerous plumose hairs; eyes two, placed upon auricular appendages.

An external parasite of *Phalangium* (the harvest-spider) and insects, at least in its early hexapodous stage.

2. *T. elongatum.* Crimson; eyes approximate. Found under stones.

3. *T. cinereum* (Pl. 2. fig. 40) (*Rhyncholophus ciner*, Dug.). Body with brown and greyish-white spots; hairs spathulate; eyes two on each side. Length 1-12″. Found in ditches amongst plants and stones.

4. *T. autumnale* (Pl. 2. fig. 38) (*Leptus autumn.*). The harvest-bug. This well-known but imperfectly examined arachnidan insinuates itself into the human skin in autumn, causing troublesome irritation. It is found on plants and the stubble of corn-fields, and may easily be caught by tying a white pocket-handkerchief around the legs, and walking through stubble-fields. The

young form with six legs is most frequently met with.

Bibl. Dugès, *Ann. des Sc. Nat.* 2 sér. i. p. 36; Gervais, *Walckenaer's Aptères*, iii. p. 178; Johnston, *Transact. of Berwickshire Naturalists' Club*, 1847, p. 221; Koch, *Deutschl. Crust. Myriap. &c.*

TRUNCATULI'NA, D'Orb.—A subgenus of *Planorbulina.* Shell discoidal, plano-convex, thick or thin, lobular or neat, adherent by the flat face; orifice slit-like, slightly apparent above and continued beneath, along the line of suture, as far as the second or third chambers.

Many recent and fossil species. *Pl. (Tr.) lobatula* (Pl. 47. fig. 9); very common, attached to sea-weeds.

Bibl. Williamson, *Rec. For.* p. 59; Carpenter, *Introd. For.* p. 207; Parker & Jones, *Phil. Trans.* clv. 381.

TRYBLIONEL'LA, Smith.—A genus of Diatomaceæ.

Char. Frustules free, linear or elliptical in front view; valves plane, with parallel transverse (tubular?) striæ, and submarginal or obsolete alæ.

In some a median line is present, in others not. The alæ are not marginal, as in *Surirella*, but arise from the surface of the valves, as shown by the diagram of a transverse section in Pl. 13. fig. 32.

T. scutellum (Pl. 13. fig. 30).

T. gracilis (Pl. 13. fig. 31).

Bibl. Smith, *British Diatomac.* i. p. 35; Rabenht. *Fl. Eur. Alg.* i. p. 347.

TRYPANOSO'MA, Gruby. See Membranes, undulating, and Undulina.

TUBER, Mich. Ssee Tuberacei.

TUBERA'CEI.—A family of Ascomycetous Fungi, growing underground or upon the surface, of more or less round form, and solid, fleshy texture, excavated with sinuous cavities lined by *asci* containing usually four or eight spores, elegantly reticulated or spinulose (figs. 768–770). The internal substance either dries and grows hard, or falls into a flocculent powder with age.

Tuber cibarium is the common truffle. Sections of the marbled internal substance show this to be composed of interlacing branched filaments, forming fleshy convolutions, between which serpentine cavities are alternately excavated; branches of the filaments free at the surface of the lacunæ bear spherical sacs (*asci*), each containing four globular spores of yellow-brown colour, having an elegantly reticulated outer coat. When the spores germinate, they produce a subterraneous cottony mycelium, which after a time presents villous nodules, in the interior of which the peridia are developed; as these advance, the villous coats gradually vanish, together with the mycelial struc-

Fig. 768.

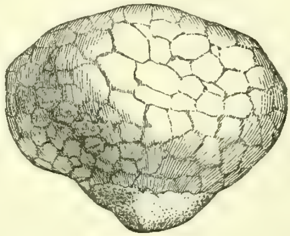


Fig. 769.

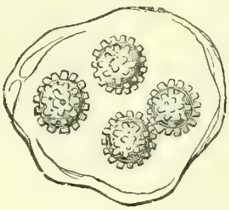
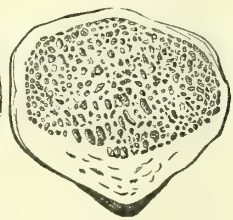


Fig. 770.



Choiromyces leonis.

Fig. 768. A peridium. Nat. size.
Fig. 769. An ascus with spores. Magnified 400 diameters.
Fig. 770. Vertical section of a peridium.

ture, and the mature peridia appear free, either a little beneath (*Tuber cibarium*) or upon the surface (*T. album*) of the soil (see also Elaphomyces).

Bibl. Berk. *Brit. Flora*, ii. pt. 2. p. 227; Tulasne, *Ann. des Sc. Nat.* 2 sér. xvi. p. 5, 3 sér. p. 348; *Monog. Fungi Hypogæi*, Paris, 1851; *Ann. Nat. Hist.* 2 ser. viii. p. 19; Lespiault, *Ann. des Sc. Nat.* 3 sér. ii. p. 316; Vittadini, *Monog. Tuberacearum*; *Monog. Lycopod. Mém. Turin Acad.* 2nd ser. v. p. 145.

TUBERCLE or Tubercular matter.—In structure, tubercle, like the other lymphomata, consists of lymphatic cells contained in the meshes of a very delicate reticulum. The cells much resemble lymph-corpuscles, and like them vary in size; and many contain a small distinct nucleus. In addition to these, there are a few larger cells containing two or even three nuclei. The nucleated cells are exceedingly destructible, so that often more free nuclei than cells are visible. The network within which these elements are enclosed, consists either of very

delicate fibres or of a homogeneous transparent-looking tissue. In most cases it is so delicate that it can only be recognized with difficulty, and the tubercle appears to consist entirely of closely crowded cells. Sometimes it is well marked; and then the tubercular granule is of a tough and fibrous consistence. The granulation blends insensibly at its margins with the surrounding tissue; and the cells in the external parts are more perfect than those in the centre, where, owing to the rapid retrograde metamorphosis which takes place, nothing is seen but the fine granular débris.

Tubercle appears invariably to originate from tissues belonging to the lymphatic system; and the tissue which surrounds the small arteries in every situation, constituting the lymphatic sheaths, is that from which it most frequently springs. The small cells in this situation multiply at separate centres, and thus miliary nodules are produced around the vessel. As they gradually develop they gradually compress the vessel, and may finally occlude it. Tubercle may originate in the same way from adenoid tissue in any situation, and especially from that which exists in the lungs in the neighbourhood of the minute bronchi. Tubercle invariably undergoes a retrogressive change; its elements being essentially unstable in their nature, become the seat of an early and rapid decay. The change commences in the centre of the granulations, and consists in the atrophy and incomplete fatty metamorphosis of the closely crowded cellular elements, constituting what is termed *caseation.* The translucent and grey granulations thus become opaque and yellowish. This yellow tubercle is merely a stage of the grey granulation. The caseous tubercle may subsequently soften or gradually dry up into a firm cheesy mass, which may be ultimately calcified (Green). (See Pl. 30. figs. 8 & 9.)

BIBL. Green, *Path. & Morb. Anat.* 1871, p. 145.

TUBERCULA'RIA, Tode.—A supposed genus of Stilbacei (Hyphomycetous Fungi), but apparently only preparatory forms of Sphæriaceous Fungi. *T. vulgaris* is a state of *Nectria* (*Sphæria*) *cinnabarina*; it is extremely common in autumn and winter, on dead sticks, damp wooden palings, stumps, &c., forming scarlet-orange rounded nodules.

TUBICLA'VA, Allman.—A genus of Athecate Hydroida.

Char. Stems erect, simple or branched, given off at intervals from a creeping stolon; cœnosarc invested by a polypary; polypites claviform, with scattered filiform tentacles. Reproduction by means of fixed sporosacs borne in clusters on the body of the polypite, immediately behind the posterior tentacle, or on the summit of very short stems developed on the creeping base.

BIBL. Hincks, *Brit. Hyd. Zooph.* p. 10; Allman, *Ann. N. H.* 3 ser. xi. p. 9, 1863.

TUBIC'OLA.—An order of Annelida.

TUBICOLA'RIA.—A genus of Flosculariæa.

BIBL. Pritchard, *Infus.* pp. 666 & 668.

TU'BIFEX, Lamk.—A genus of Annulosa, of the order Oligochæta.

Char. Body filiform, attenuated at the ends, pellucid, with four rows of setæ—two dorsal and two ventral.

The worms live and burrow in the mud of stagnant pools or the still parts of rivers, giving it a red appearance. When the water or mud is disturbed, the red patches instantly disappear, from the retraction of the animals. Length from 1-5 to 3-4″ or more.

They are transparent, and show well the alimentary canal, with its peristaltic actions, and the cilia lining it, the blood-vessels and their movements, with the loops bathed in the chylaqueous liquid, and the coiled water- (respiratory or renal) vessels with their cilia.

BIBL. Schmidt, *Müller's Archiv*, 1846, p. 406; Dugès, *Ann. des Sc. Nat.* 2 sér. xv. p. 319; Johnston, *Ann. Nat. Hist.* 1845, xvi. p. 443; E. Ray Lankester, *Qu. Micr. Journ.* 1871, p. 180.

TUBULA'RIA, Linn. — A genus of Hydroida, and family Tubulariidæ.

BIBL. See TUBULARIIDÆ.

TUBULARI'IDÆ.—A family of Athecate Hydroida.

Char. Polypites flask-shaped, with two sets of filiform tentacles, one oral, the other near the base.

Tubularia. Stem twisted, branched or unbranched; tentacles filiform in two rows; gonophores on short footstalks, clustered at the bases of the lower tentacles.

Corymorpha. Partly enclosed; polypidom short, thin, membranous, swollen at the base, which is immersed in the sand; polype single, head club-shaped, encircled at the base by long filiform tentacles, and a circle of short ones around the tip.

Ectopleura. With free medusiform gonozooids.

BIBL. Hincks, *Brit. Hyd. Zooph.* p. 114; Lister, *Phil. Trans.* 1834; Johnston, *Brit. Zooph.* 48; Mummery, *Qu. Micr. Jn.* 1853, p. 28; T. S. Wright, *Edinb. New Phil. Jn.* 1858, p. 113; Allman, *Ann. N. Hist.* July 1859, and July 1864; Van Beneden, *Mém. sur les Tubul.*

TUBULIP'ORA, Lam.—A genus of Infundibulate Cyclostomatous Polyzoa, of the family Tubuliporidæ.

Many British species. Some of them are common upon shells, sea-weeds, &c.

Pl. 33. fig. 30 represents a species (not British).

BIBL. Johnston, *British Zoophytes*, p. 266.

TUBULIPOR'IDÆ.—A family of Infundibulate Cyclostomatous Polyzoa.

Char. Polypidom calcareous, massive, circular, lobed or divided dichotomously; cells long, tubular, with a round, prominent, unconstricted orifice. Genera:

1. *Tubulipora.* Wart-like, with a defined base; cells suberect, aggregated or in imperfect rows, more or less free at the end.

2. *Diastopora.* Incrusting, undefined; cells alternate, tubular, horizontal, immersed, with a raised circular orifice.

3. *Idmonea.* Divided dichotomously, erect; cells on one side, tubular, in transverse rows, divided into two sets by a median longitudinal line.

4. *Pustulipora.* Erect, cylindrical; cells semi-immersed, on all sides, orifices prominent.

5. *Alecto.* Creeping, adherent, irregularly branched; cells horizontal, in one or more rows, their ends free.

BIBL. Johnston, *British Zoophytes*, p. 264; Gosse, *Mar. Zool.* ii. p. 7.

TUMOURS. — Non-inflammatory new formations. For *Fibro-plastic, fibro-nucleated, recurrent fibroid,* and *myeloid* tumours, see SARCOMATA.

The fully developed connective tissue originates the *fibromata* or *fibrous* tumours. They present the same variations as those met with in connective tissue. Some are composed of firm, dense fibrous tissue, such as constitutes tendons; others are larger and resemble the connective tissue of the cutis. The fibres which constitute the greater part of the growth may be closely interlaced without any definite arrangement, or they may be grouped in bundles of various sizes. The cells or connective-tissue corpuscles are very few in number, and usually only become visible on the application of acetic acid. They are often minute spindle-shaped, fusiform, or stellate bodies, the latter having processes of varying length, which communicate with those from neighbouring cells. They contain in some instances an oval nucleus. The slower the growth the smaller and less numerous are the cells.

Gummata consist of a granulation tissue, formed by the rapid production of an embryonic connective tissue, which then is analogous to the structure of inflammatory granulations. They are very incompletely organized, and soon undergo retrogressive changes; and hence the growth is ultimately made up of atrophied, degenerated, and broken-down cell products, imbedded in an incompletely fibrillated tissue.

Myxomata are tumours consisting of mucous tissue, and are closely allied to the sarcomata. Mucous tissue is a translucent and succulent connective tissue, the intercellular substance of which yields mucin. These tumours always originate from one of the connective tissues. Adipose tissue is their favourite seat; they grow from bone (medullary tissue of), the connective tissues of organs, of the brain, spinal cord, and nerves. They are usually incapsuled; and their growth is slow and often very great. They are of a peculiar soft gelatiniform consistence, and of a pale greyish or reddish-white colour. On scraping the cut surface they yield a tenacious mucilaginous liquid, in which may be seen the cellular elements of the growth. The cells are angular and stellate, with long anastomosing prolongations and trabeculæ; and others are isolated, fusiform, oval, or spherical, with one or two nuclei.

Lipomata. Fatty tumours resemble adipose tissue, and consist of cells containing fat united by a variable quantity of connective tissue.

The *Enchondromata* and *Osteomata* are tumours consisting of cartilage and bone respectively; and the *Lymphomata* are new formations consisting of lymphatic or, as it is usually termed, adenoid tissue.

The *Papillomata,* such as warts, horny growths, polypi, originate from the skin and mucous membranes, of whose tissues they may be called exaggerations. The *adenomata,* or tumours of glands, are new formations of gland tissue. They resemble the racemose glands, and consist of numerous small saccules or tubes filled with squamous or cylindrical epithelium-cells. These are grouped together, being merely

separated by a small amount of connective tissue in which are blood-vessels.

The *carcinomata*, or cancers, are new formations consisting of cells of an epithelial type, without any intercellular substance, grouped together irregularly within the alveoli of a fibrous stroma. There are the four following varieties—scirrhus, encephaloid, epithelioma, and colloid. These, although all possessing the same general characters, present certain structural differences which serve to distinguish them. As a class, the carcinomata consist of cells of an epithelial type; and they are characterized by their large size, diversity of form, and by the magnitude and prominence of their nuclei and nucleoli. In size they vary from 1-600 to 1-1800″, the majority being about five times the size of a blood-corpuscle. They are:—

Scirrhous, fibrous, or chronic cancer, characterized by a large amount of the fibrous stroma. The cell-growth may be luxuriant at first, but it soon subsides. See SCIRRHOUS CANCER, page 689.

Encephaloid, medullary, or acute cancer, differs from scirrhous principally in the great rapidity of its growth, the small amount of its stroma, and the amount of its cell-structure. It is soft, with a brain-like consistence, the central portions being often diffluent.

Epithelioma always grows in connexion with cutaneous or mucous surfaces; and its cells resemble the squamous variety of epithelium. They vary in size from 1-800 to 1-1000″ in diameter, and usually, but not invariably, contain a single nucleus. The arrangement of the cells is peculiar: the majority of them are situated on irregular tubular-shaped lobules; others are less regularly grouped in masses of various sizes amongst the meshes of the stroma. As the cells increase in number, they become arranged concentrically in groups so as to form globular masses. In these masses, as the epithelium multiplies, the peripheral layers of cells become flattened by pressure. These are the concentric globes or epithelial nests characteristic of this form of cancer. The stroma presents every variety between rapidly growing embryonic tissue and dense fibrous tissue, round, oval, fusiform, caudate, polygonal, and the variation in form is usually produced by pressure. The nuclei are large and prominent, and are round or oval, and contain one or more bright nucleoli. One or two nuclei may be present; but in some forms there are many in each cell. The cells rapidly undergo retrogressive changes, and then contain much molecular fat, and they are often so readily destructible that more free nuclei than cells are visible. Cells precisely the same as these are met with in other growths and in normal tissues; so that there is no specific "cancer-cell." It is the general character of the cells, together with their distribution in the meshes of a fibrous stroma, that determines the nature of the growth to which they belong. The stroma varies considerably in amount, being much more abundant in some forms of cancer than in others. It consists of a fibrillated tissue forming alveoli which communicate; and its structure varies with the rapidity of its growth. If this be rapid, it will contain numerous round spindle-shaped cells; but, on the other hand, if it be slow, or has ceased, there will be few cells, and the tissue will be densely fibrillated. The blood-vessels are in the stroma; and hence the cancers differ from the sarcomata, where the blood-vessels ramify even amongst the cells, and are not restricted to the stroma.

Colloid, or alveolar cancer. In this form, which appears to be really a variety of the others, the alveoli of the stroma are well marked and more or less spherical in shape. Within them is contained a gelatinous or colloid material, which is a glistening, translucent, colourless, or yellowish substance of the consistence of thin mucilage or size-gelatin. In the main it is perfectly structureless; within it, however, are imbedded a very great number of epithelioid cells, which also contain the same gelatinous substance. They are large and spherical, and are distended with the substance, being imbedded in it also.

Myomata, *neuromata*, and *angiomata* are muscular, nervous, and vascular tumours respectively,—the first two having some of the usual microscopic characteristics of muscle and nerve; and the last consist of blood-vessels held together by a small amount of connective tissue. The angiomata are simple when in the form of nævi, for instance. The dilated blood-vessels are a new formation superinduced in the original vessels of the part: they are usually capillary; and the venous or the arterial tubes may be in excess, according to the kind. They are termed cancerous when they consist of large veins, or are erectile. In this last case the growth is made

up of irregular fibrous alveoli, which communicate freely with each other, and are lined with an epithelium similar to that of the veins.

Cystic tumours are new formations. A cyst is a cavity containing liquid or pultaceous material, which is separated from the surrounding structures by a more or less distinct capsule. It may be a new formation, or the result of disease on a pre-existing structure which has become distended by its own secretion or by extravasation into it. The independent formation of a cyst may take place by the softening and liquefaction of the tissues in some particular parts, owing to mucoid or fatty changes. The tissues around the softened matters become condensed, and ultimately form a kind of cyst-wall; also by the enlargement and fission of the spaces in connective tissue and the accumulation of fluids within them the surrounding tissue becomes condensed and forms a cyst-wall; and this may in some cases become lined with secreting cells. Finally, cysts may form by the formation of a cyst-wall around foreign bodies, parasites, or extravasated blood. The structure of the cyst-wall will vary according to the nature of the old tissue in which it is formed, or whether it is entirely developed from a new formation of tissue. In the first instance there is usually an epithelial lining; but this is not seen in the last. Moreover the cyst-wall is either intimately connected with the surrounding tissues or is not. For cancerous structures, see Pl. 30. figs. 11, 12, 17, 21.

In the examination of tumours and other morbid growths, sections should be made with a Valentin's knife, the elements being first observed in water, and then in the natural fluid. The sections and elements are best preserved in water.

Bibl. Paget, *Lectures on Tumours* (1851), and *Surgical Pathology*; the *Bibl.* of Tubercle; Bennett, *on Cancer*, and *Edinb. Monthly Journ.* vii. & viii.; Redfern, *ibid.* xi.; and the *Trans. of Pathol. Soc.*, passim; Green, *Path. & Morbid Anatomy*; Rindfleisch's *Manual.*

TUNICA'TA.—A class of animals, of the subkingdom Mollusca, division Molluscoida.

Char. Marine; often microscopic; bodies single, social, or aggregate; acephalous; enclosed in an elastic tunic with two orifices, one oral and branchial, the other anal or cloacal; a large atrial system, the pharynx communicating with it by branchial slits; respiration branchial, branchiæ pharyngeal; nervous system a ganglion; circulation effected by a tubular heart, with vessels, the current of blood varying in direction; hermaphrodite; evolution accompanied by metamorphosis, or following the law of alternation of generations (Pl. 43. figs. 10, 20).

The smaller Tunicata are commonly found aggregate, and investing rocks, stones, and shells; some are adherent to sea-weeds, &c., a few are free; many are common on the sea-shore.

The body is sac-shaped or elongate, sometimes slightly constricted so as to exhibit a thorax, abdomen, and a posterior portion or postabdomen. The outer coat, test or tunic, is cartilaginous, leathery, gelatinous, or membranous; and consists partly of cellulose, often containing calcareous spicula. Within this is another coat, the mantle, usually adhering to the former at the orifices only, and containing numerous muscular fibres. The oral orifice or opening of the usually dilated pharynx or branchial cavity, within which is placed the branchial apparatus (Pl. 43. fig. 10, *b*), leads to the mouth (*a*). This is slit-like, and leads into a narrow œsophagus (*e*); to this succeeds an expanded stomach (*s*), which terminates in a longish intestine with a hæmal curve (*i*), and ends at the base of the cloaca (*i**), which opens externally at the atrial orifice. Within the oral orifice, at the commencement of the branchial cavity, is a ring of rudimentary tentacles.

The branchial apparatus in the pharynx (fig. 10, *b*) consists of numerous cross bars, with slit-like openings between them; these are ciliated, and copiously supplied with networks of blood-vessels. The slits open into the atrial system. The current excited by the cilia draws the water through the oral orifice into the pharynx, where it traverses the openings, flowing outwards to collect in the cloaca, from which it is expelled through the atrial orifice. In some of the larger Tunicata, the branchial apparatus is strap-shaped, and traverses the body obliquely.

The heart (*h*) is a spindle-shaped sac, enclosed in a pericardium (*p*), and situated near the base of the body, the principal vessels running on the dorsal and ventral surface of the branchial apparatus. The current of blood varies in direction, being at one time expelled from one end of the heart, at others from the other. In those

Tunicata which are connected by a common tube, the blood passes freely from one to the other.

The nervous system consists of a single ganglion (fig. 10, *g*), situated between the two orifices, and giving off its principal branches to the branchial sac and the alimentary canal. In some an eye is present, resembling the compound eye of the Articulata, and with a reddish pigment.

Moreover an auditory capsule has been noticed in some genera.

The liver (*l*) consists either of a dark glandular layer lining the alimentary canal, or of distinct glandular cæca.

The Tunicata are reproduced by gemmation, by sexual organs, and by intermediate generations.

The testis (*t*) and ovary (*o*) are usually strap-shaped organs, either adherent to the alimentary canal, or situated in the posterior part of the body; the former has a long spermatic duct (*d*), which opens into the cloaca, into which also the ova or larvæ are discharged, to escape by the posterior orifice. The larvæ often resemble at first tadpoles with three anterior sucker-like organs, by means of which they adhere to foreign bodies to complete their development, the tail gradually disappearing.

In *Appendicularia* the larval form persists through life.

The larval caudal appendage has been shown to have a rod-like body, which has been compared to the chorda dorsalis of Vertebrata.

In the large free Tunicata, the intermediate generations are united into long chains, the final product being a sexual individual; but into the further structure of these curious beings we have no space to enter.

Synopsis of the Families.

* *Attached*; *mantle and test united only at the orifices.*

1. Botryllidæ. Bodies united into systems.
2. Clavelinidæ. Bodies distinct, but connected by a common root-thread.
3. Ascidiadæ. Bodies unconnected.

** *Free*; *mantle and test united throughout.*

4. Pelonæadæ. Orifices near together.
5. Salpidæ. Orifices at opposite ends.

Bibl. M.-Edwards, *Mém. s. les Ascid. Comp.*, and *Mém. de l'Institut*, 1842; Forbes and Hanley, *Brit. Moll.* i. p. 1; Vogt, *Zool. Briefe*, i. p. 258; Siebold, *Vergleich. Anat.* p. 234; Lister, *Phil. Trans.* 1834; Huxley, *ib.* 1851; Rupert Jones *in Todd's Cyclop. Art. Tunicata*; Carpenter, *Micros.* p. 584; Allman, *Qu. Mic. Jn.* vii. p. 86; Gegenbaur, *Sieb. u. Koll. Zeit.* B. vi. p. 406; Alder, *Ann. Nat. Hist.* 1863, xi. p. 153; Hancock, *Jn. Linn. Soc.* ix. p. 309; Peach, *on Pres. of Ascidians, Qu. Mic. Jn.* 1872, p. 162.

See Phallusia, Appendicularia, and families.

TURBELLA'RIA.—An order of Annuloida.

TURBINEL'LA, Schultze.—A genus of Ichthydine Rotatoria.

Bibl. M. Schultze *in Müller's Archiv*, 1853, p. 241; Pritchard, *Infusoria*, p. 381.

TURMERIC. See Curcuma.

TUR'RIS, Lesson.—A genus of Athecate Hydroids, family Clavidæ.

Char. Stems short, rooted by a filiform stolon bearing the polypites on their summits; the cœnosarc invested by a polypary; polypites claviform, with scattered filiform tentacles. Gonozooid free and medusiform. Umbrella subcylindrical, with 4-8 longitudinal bands; manubrium massive, four-lipped, radiating canals 4, marginal tentacles numerous, each with an ocellated bulbous base. *T. neglecta*, in the Solent, Ilfracombe, &c.

Bibl. Forbes, *Brit. Naked-eyed Medusæ*, p. 23; Gosse, *Devonshire Coast, &c.*, p. 348; Allman, *Ann. Nat. Hist.* 1864, xiii. p. 352; Hincks, *Brit. Hyd. Zooph.* p. 13.

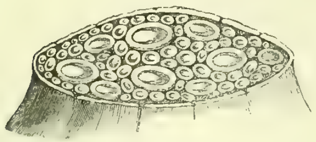
TY'PHOUS CELLS (or Typhoid Cells).—In typhoid fever the morbid process culminates in the production of a cell, which outruns the ordinary pus-corpuscle in the degree of its individual development. The special cells, although small uninuclear elements, yet contain more protoplasm, and are therefore larger, than lymph-cells, pus-corpuscles, and white blood-corpuscles. Crowded into a confined space, they assume an irregular and often polygonal form. Degenerative changes speedily commence, and the cells break up, mostly by fatty metamorphosis, into oily débris capable of reabsorption. These cells are found not only in the intestinal structures primarily involved in typhoid, but also in other organs; for instance, they are occasionally found forming medullary masses on the pleural surface and inside the very sarcolemma of muscles.

See Myositis.

BIBL. Rindfleisch, *Path. Hist. Syd. Soc.* (tr. Baxter), ii. 377.

TYM'PANIS, Fr.—A genus of Phacidiacei (Ascomycetous Fungi), consisting of horny bodies growing on branches of trees, breaking out through the bark. *T. conspersa* (fig. 771) grows upon Rosaceous trees, *T. saligna* on the privet. In the former the perithecia are collected in tufts; they are first closed, afterwards opening into cups, the disk of which is occupied by the hymenium, bearing long and broad asci containing numerous spores, and sometimes also septate stylospores simultaneously. In *T. saligna* the perithecia occur only two to four together. *Spermogonia* exist (which are oblong or conical bodies) intermixed with the perithecia, perforated by a terminal pore (resembling perithecia of *Sphæria*); these are lined with delicate branched filaments bearing minute corpuscles (*spermatia*), which when mature escape from the pore in a tendril (as in *Cytispora*) if moistened or pressed (see also CENANGIUM).

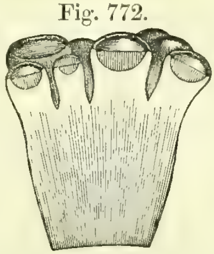
Fig. 771.



Tympanis conspersa.

A collection of perithecia, more or less mature, bursting through the bark. Magn. 10 diams.

Fig. 772.



Vertical section through a piece of the above, passing through some of the open cup-like perithecia.
Magnified 20 diameters.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 210; *Ann. Nat. Hist.* 2 ser. vii. p. 185; *Hook. Journ. of Botany*, iii. p. 322 (1851); Tulasne, *Ann. des Sc. Nat.* 3 sér. xx. p. 143, pl. 16. figs. 15, 16; Fries, *Summa Veg.* p. 399; Greville, *Sc. Crypt. Fl.* pl. 335.

TYPH'LINA, Ehr.—An imperfectly examined genus of Rotatoria, of the family Philodinæa.

T. viridis (Pl. 35. fig. 33). Found in Egypt.

BIBL. Ehrenberg, *Infus.* p. 483.

U.

U'LOTHRIX.—A genus of Confervoid Algæ, probably referable to the Confervaceæ, allied to *Draparnaldia* and *Stigeoclonium*. They consist of unbranched filaments adhering loosely together to form a mucous stratum, growing upon stones &c. in fresh water. The filaments are composed of short hyaline cells (Pl. 5. fig. 6), the green contents of which are at first granular, adhering to the walls (*a*), then contracted into transverse bands (*b*), and finally converted into two, four, or more zoospores, with four cilia (*c*).

BIBL. Kützing, *Sp. Alg.* p. 345; *Tab. Phyc.* ii.; Hassall, *Brit. Fr. Alg.* p. 219; Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. p. 222, pl. 18; Rabenht. *Fl. Eur. Alg.* i. p. 370.

UL'VA, Linn.—A genus of Ulvaceæ (Confervoid Algæ), here taken in the sense of Thuret. The plants are all marine, consisting of broad, green, simple or lobed, membranous fronds, growing upon rocks and stones. The cells are rounded-angular (Pl. 5. figs. 2 & 3), and are at first filled with amorphous green colouring-matter, which subsequently becomes collected into masses (*a*), ultimately converted into numerous zoospores. Under the influence of light, these soon "swarm" and break out from the cells by a pore in the outer wall (fig. 3 *b*). The emptied cells give a pale colour to the parts of the frond where they are situated. The zoospores appear in two forms, some large and bearing four cilia (fig. 3 *c*), others much smaller and possessed of only two cilia (fig. 2 *b*). The fronds in which the latter occur are generally of a yellower colour. Thuret has seen both kinds germinate. As defined by that author, the British species stand as follows:—

1. *U. Lactuca*, L. Frond broadly ovate or oblong, 6 to 18″ long, and several inches wide.

β. latissima. Frond 3′ or more long, 18″ or more wide; found in the muddy water at the entrance of harbours (*Phycoseris Myriotrema*, Kütz. *Sp. Alg.*) = *U. orbiculata*.

2. *U. Linza*, L. Frond linear-lanceolate, 6 to 24″ long, $\frac{1}{2}$ to $1\frac{1}{4}$″ wide.

BIBL. Harvey, *Brit. Mar. Alg.* p. 216, pl. 25 B; Thuret, *Mém. de la Soc. de Cherbourg*, ii. (1854); *Ann. des Sc. Nat.* 3 sér. xiv. p. 224, pl. 20; Greville, Harvey, Kützing, *ll. citt. supra*; Rabenht. *Fl. Eur. Alg.* i. p. 316.

ULVA'CEÆ.—A family of Confervoid

Algæ. Marine or freshwater Algæ, consisting of membranous, expanded, saccate or tubular, sometimes filiform fronds, composed of spherical or polygonal cells, united together firmly into layers, either single or double. Reproduced by roundish spores formed from the whole contents of cells, or by ciliated zoospores formed in twos, fours, or many in each cell. See genera ULVA, ENTEROMORPHA, MONOSTROMA, PRASIOLA, and SCHIZOGONIUM.

UMBILICA'RIA, Fée (*Gyrophora*, Ach.).—A genus of Pyxineæ (Gymnocarpous Lichens). *U. pustulata* grows on rocks in various parts of Britain. It is remarkable for the tubercles or hollow papillæ occurring on its surface. The apothecia are flat, and at first black, at length tuberculate. Spermogonia also occur, in the form of little tubercles containing a nucleus of densely packed sterigmata, enclosed by a thin black rind. The species in which the disk of the apothecia is concentrically plicate form the proper *Gyrophoræ* of Ach.; they occur on mountain-rocks.

BIBL. Hook. *Brit. Flor.* ii. pl. 1, p. 223; Tulasne, *Ann. des Sc. Nat.* 3 sér. xvii. p. 207, pl. 5. figs. 5–12; Schærer, *Enum. crit.* p. 25.

UNDULI'NA, Lankester = *Trypanosoma*, Gruby. See MEMBRANES, UNDULATING, and *Qu. Mic. Jn.* 1871, p. 387.

UNICELLULAR ALGÆ. See PALMELLACEÆ.

UNILOCULI'NA, D'Orbigny.—A subgenus of *Miliola*.

Char. Shell regular, equilateral, globular; *chambers* completely embracing, regularly wound round the axis, one only apparent, this making a complete revolution around the preceding; cavity simple; *orifice* single, with a tooth.

In the other genera of the family, each chamber occupies only half the circumference, whilst here it forms a complete circle. One species, *U. Indica* (Pl. 18. fig. 2).

BIBL. D'Orb. *For. Fos. Vien.* 261.

URATES. See URIC ACID.

URCEOLA'RIA, Ach.—A genus of Parmeliaceæ (Gymnocarpous Lichens), included under *Parmelia* by Fries, but agreeing in almost every particular with LECANORA. *U. scruposa*, the commonest species, grows on heaths, walls, and rocks. The disk of the apothecia is black, and the border crenated. The spores are cellular or multilocular (Pl. 29. fig. 17). The spermogonia are scattered over the thallus, sometimes in the outer wall of the (thallodal) border of the apothecia; they are very inconspicuous, on account of the light colour of their ostiole.

BIBL. Hook. *Brit. Flor.* ii. pt. 1. p. 175; Tulasne, *Ann. des Sc. Nat.* 3 sér. xvii. p. 172, pl. 4. figs. 5–14; Schærer, *Enum. crit.* p. 85.

URCEOLA'RIA, Duj.—A genus of Infusoria, consisting of *U. stellina*, D. (= *Trichodina pediculus*, E.), and three doubtful species described by Müller.

BIBL. Dujardin, *Infus.* p. 525.

URE'A.—This substance occurs normally in the urine of man and the carnivora, in small quantity in that of the herbivora; also in the amniotic liquid, and the vitreous and aqueous humours of the eye. Pathologically, it is found in the blood, dropsical effusions, vomited liquids, and doubtfully in the saliva, the bile, and perspiration.

When pure, it forms colourless four-sided prisms, sometimes longitudinally striated, and with one or two oblique terminal facets. The crystals are readily soluble in water and alcohol, but not in pure ether.

When nitric or oxalic acid is added to a solution of urea, the nitrate or oxalate separates in the crystalline form.

The nitrate of urea, when rapidly formed, consists of irregularly aggregated scaly crystals (Pl. 9. fig. 18 *c*); when more slowly formed, rhombic or hexagonal plates, or distinct prisms (Pl. 9. fig. 18 *a, b*). The crystals of the nitrate of soda (Pl. 6. fig. 19) bear some resemblance to those of the urea salt.

The crystals of the oxalate of urea somewhat resemble those of the nitrate, the rhombic form being evident.

BIBL. That of CHEMISTRY, *Animal*.

UREDIN'EI.—The genus *Uredo* is shown by Tulasne to have no satisfactory claim to a distinct existence, since the structures which have represented it appear to be merely a form of the reproductive organs common to a number of plants, which, in their most perfect state represent the genera *Puccinia*, *Phragmidium*, *Uromyces*, &c. These constitute the genera of the family Uredinei.

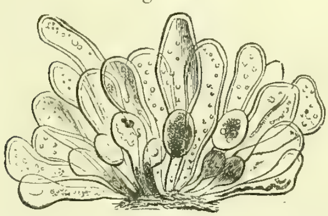
Of the genus *Phragmidium*, *P. bulbosum* (*Puccinia rubi*, Schær.) is a species commonly occurring on the leaves of brambles, forming reddish, then orange, and finally blackish rusty spots (fig. 773). The first signs of reproductive organs appear in the middle of the spots on the upper face of the leaf, consisting of a few minute unilocular cavities (*spermogonia*) excavated in

the leaf, with a little flat ostiole; in these occur ovate *spermatia* (see ÆCIDIUM), which are accompanied by a yellowish mucous liquid, and are expelled with this in the form of drops. Subsequently to this, the *Uredo*-fruits are developed, mostly on the lower face of the leaf, at the back of the spermogonia, or more rarely on the upper face, in a circle around them. They are pulverulent patches (fig. 773), solitary or a few together; and a vertical section (fig. 774) shows them to consist of paraphyses (fig. 775), and simple or branched short filaments bearing globose *stylospores* (fig. 776), which soon become detached, and in ripening acquire an echinate outer coat with numerous pores. When these

Fig. 773.

Leaf of bramble, with "Uredo ruborum." Half the nat. size.

Fig. 774.



Vertical section of the same Uredo-fruit, with paraphyses and imperfect stylospores. Magnified 460 diams.

germinate, they produce merely a long slightly branched filament. Finally the perfect fruits (*spores*) appear on the same, or in distinct sori (on the lower face of the leaf), in the form represented in fig. 565 (p. 597). The loculi of these have each three or four pores in the upper part of the side-walls, whence emerge in germination (in spring) short tubular filaments, which soon divide into four cells, from each of which arises a minute "sporidium" borne on a pointed sterigmatous process.

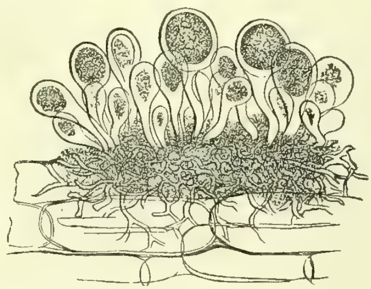
Puccinia compositarum exhibits very similar phenomena; its *Uredo*-fruit has been described as *Uredo suaveolens.* Fig. 777 represents a vertical section through an immature sorus of this; fig. 778 some of the *stylospores* detached and germinating; the

Fig. 775.

Fig. 776.

Fig. 775. Separate paraphyses.
Fig. 776. Detached pedicels with stylospores.
Magnified 460 diameters.

Fig. 777.



Vertical section of the sorus of "Uredo suaveolens," with immature stylospores. Magnified 460 diameters.

Fig. 778.

Ripe stylospores of the same, germinating. Magnified 460 diameters.

Fig. 779.

Fig. 780.

Deformed stylospores, with the spinulose coat developed. Magnified 460 diameters.

outer spinulose coat is here fully developed, and the tubular filaments are seen emerging from the pores. The spores of the perfect fruits of this genus differ from those of *Phragmidium* in being only bilocular, or, by abortion, unilocular (see PUCCINIA).

In ÆCIDIUM, CYSTOPUS, and some other genera, only *spermogonia* and *stylosporous* fruits (*Uredo-fruits*, Tulasne) have been observed. In *Cronartium*, *spermogonia* are unknown, but the *Uredo*-fruit exists. In *Podisoma* both *spermogonia* and *Uredo*-fruits are unknown; in both of these genera the *perfect* fruits are placed on a fleshy *columella* or *ligula*.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. arts. *Æcid.*, *Pucc.*, *Uredo*, *&c.*; *Ann. Nat. Hist.* i. p. 264, 2 ser. v. p. 463; Tulasne, *Ann. des Sc. Nat.* 3 sér. vii. p. 12, 4 sér. ii. p. 77; Léveillé, *ibid.* 3 sér. viii. p. 369; De Bary, *Brandpilze*, Berlin, 1853; Fries, *Summa Veg.* p. 509; Unger, *Exanthem. Plant.*; and the works cited under the Genera.

URIC ACID and URATES, or lithic acid and lithates.—Uric acid may easily be procured in small quantity from human urine, by adding a few drops of dilute muriatic acid, and setting the liquid aside for some hours, when it subsides in crystals. In larger quantity it may be obtained by heating the excrement of serpents with excess of dilute solution of potash, until the odour of ammonia has disappeared, and filtering the solution whilst hot into dilute muriatic acid, when it falls in a colourless state. Or the excrement may be digested, without heat, with excess of strong sulphuric acid, the mixture set aside that the impurities may subside, and subsequently poured gradually into a large quantity of distilled water.

It exists also in the excrement of birds, in the urine of Mollusca and Insecta, and of all the Mammalia, excepting those which are herbivorous; it has also been found in the human blood, of which it is probably a normal constituent in minute quantity, although mostly secreted with the urine as soon as formed.

In the natural state of solution in the urine, uric acid exists combined with soda and ammonia; but it is frequently found as an abnormal deposit in the human urine, and is often precipitated after the secretion has been evacuated, from the occurrence of an acid fermentation. The crystals of the free acid are sometimes also met with in the urine or excrement of the lower animals, as Insects, &c.

Uric acid is but little affected by water, alcohol, acetic or muriatic acid, slowly soluble in solution of ammonia, but readily in solution of potash, from which it is re-precipitated by a dilute acid.

The crystals belong to the right-rhombic prismatic system.

Their various forms are represented in Pl. 8. figs. 1–10, and fig. 15. Those in fig. 1 are frequently met with as natural deposits from human urine, although most of the same forms, with those in fig. 15, are also found in the artificially precipitated acid. The most common and characteristic form is the rhomb (*a*), the side view being linear or rectangular. When the urine is strongly acid, the crystals often appear striated from the presence of linear fissures (*c*, *d*). Sometimes they are narrower and more elongate, with a prismatic form (*e*). They are frequently aggregated, and either fused into twin crystals (*f*, *g*), or form aigrettes or tufts (*k*, *l*, *m*, *n*, *o*). The other forms are noticed in the description of the plate.

The crystals forming a natural deposit are almost invariably coloured, from combining with the colouring-matter of the urine; sometimes their colour is very brilliant (fig. 4); they may also be coloured artificially by precipitation from a solution of purpurate of ammonia (fig. 3), madder, &c.

The test for uric acid is the production of the colour of purpurate of ammonia or murexide, which may be effected by dissolving the crystals or suspected substance in a small quantity of dilute nitric acid, gently evaporating the solution to dryness, and adding a little ammonia to the residue, or exposing it to the vapour of ammonia, when the red colour becomes visible. But the rhombic form, when present, with the action of potash and dilute acid, would be sufficient to distinguish uric acid from most substances.

The formation of the crystals of uric acid presents an interesting object for examination. A drop or two of solution of uric acid in potash is first placed upon a slide and covered with thin glass; a little dilute muriatic acid is then applied to the edge of the liquid, or a drop of strong acetic acid placed near its edge, so that the vapour may be absorbed by the liquid. The latter soon becomes turbid, from the formation of a precipitate of numerous molecules and granules. If the turbid liquid be watched under the microscope, a minute crystal will presently be seen to form suddenly in some part of

the field. The molecules and granules then slowly dissolve immediately around the crystals, leaving this in the middle of a clear space. The crystal now enlarges, and the surrounding molecules gradually disappear, until they at last entirely vanish from the field. By careful inspection, it may easily be seen that the crystal is not formed by the conflux of the precipitated molecules, but is deposited from a state of solution.

Some crystals of uric acid polarize light splendidly, and some of the feathery crystals (Pl. 8, fig. 8 *e*) possess considerable analytic power.

The forms of the crystals and crystalline groups of the urates are represented in Pl. 8. figs. 11–14; they are not very characteristic, and the aid of chemistry is required for determining with certainty the composition of the respective crystals.

The urate of ammonia may be prepared artificially by adding ammonia to a boiling mixture of uric acid and water; the urate of lime by mixing urate of potash with chloride of calcium; the urate of soda by dissolving uric acid in solution of soda; and the urate of magnesia by mixing solutions of sulphate of magnesia and urate of potash.

The presence of an excess of uric acid in the blood is the chemical expression of gout; it leads to an abnormal precipitation of urates in various parts of the body. In cartilage the cells are the chief depositories of the urates of soda and lime, and they form the centres of the stellate bundles of crystals by which the tissue is permeated. The appearance of cartilage thus affected is very characteristic; and each cartilage cell is surrounded by radiating tufts of crystals which nearly or quite touch the extremities of other groups radiating from neighbouring cells. See URINARY DEPOSITS.

BIBL. Rindfleisch, *Path. Hist.* ii. p. 270; and that of CHEMISTRY, *Animal.*

URINARY DEPOSITS.—We shall give here a list of the deposits most commonly occurring in the human urine, with the references to the plates in which they are represented, and the articles in which they are described.

Since the publication of the important paper, by Vigla (*L'Expérience,* 1839), in which most of these deposits were first illustrated, the use of the microscope has constantly been called in to aid in their detection. In regard to the pathological indications afforded by their presence, upon which we cannot enter, it may be remarked that most of the deposits are formed after the evacuation of the urine.

Uric acid. Pl. 8. figs. 1, 2; and *Urates,* Pl. 8. figs. 11 *c, d, e,* 13 *a,* 14 *a* (URIC ACID and URATES).

Oxalate of lime. Pl. 9. figs. 9, 10, 11, 12 (LIME, Salts of). The concretionary forms of this salt (figs. 10, 11, 12) are more slowly acted upon by reagents than simple crystals.

Ammonio-phosphate of magnesia. Pl. 9. figs. 1, 2, 3, 4 (MAGNESIA, Salts of).

Carbonate of lime. Pl. 9. fig. 8 (LIME, Salts of).

Cystic oxide. Pl. 9. fig. 5 (CYSTIC OXIDE).

Blood-corpuscles. Pl. 40. fig. 21, especially the form fig. 21 *e* (BLOOD).

Mucous corpuscles. Pl. 1. fig. 5 (MOUTH, p. 511).

Pus-corpuscles. Pl. 30. figs. 4, 5 (PUS).

Spermatozoa. Pl. 41. fig. 25 (SPERMATOZOA). These are found in the urine of the female for several days after intercourse; and we have detected them in the uterus more than a fortnight after the same.

Sarcina. Pl. 3. fig. 5 (SARCINA).

Fungi. Penicillium (fig. 557, page 585; Pl. 20. fig. 15) and *Torula* (Pl. 20. fig. 7). The spores of *Penicillium* form the so-called small organic globules.

Casts of the tubuli uriniferi. The extreme diameter of these is rather less than that of the tubules; but they are often much more slender. They are cylindrical, generally wavy, sometimes hollow, at others solid. Some are very transparent, finely granular, and are composed of fibrine; others consist entirely of, or contain imbedded in them, renal epithelial cells, with or without globules of fat either free or within the cells; they sometimes also contain mucous and pus-corpuscles, with blood-globules; some of the epithelial cells occasionally contain lithates. The epithelium of the bladder agrees essentially in structure with that of the pelvis of the kidney (KIDNEY, p. 439).

BIBL. That of CHEMISTRY, *Animal*; Lehmann, *Phys. Chem.*; Bird, *Urinary Deposits*; Schmidt, *Versuch. &c.*; Griffith, *Urinary Deposits* and *Med. Gaz.* 1843.

URNATEL'LA, Leidy. — A genus of freshwater Polyzoa.

Not yet found in Britain.

BIBL. Leidy, *Proc. Acad. Nat. Sc. Philadelphia,* v. & vii.; and Allman, *Freshwater Polyzoa,* 117.

UR'NULA, Clap. et Lach.—A genus of Actinophryina, Rhizopoda.

Char. Sheath membranous and fixed to other bodies. 1 sp. *U. Epistylidis.*

BIBL. Clap. et Lach. *Etudes*, p. 457.

UROCENTRI'NA. A family of Ciliate Infusoria. See p. 410.

BIBL. Clap. et Lach. p. 134.

UROCEN'TRUM, Nitzsch, Ehr.—A genus of Infusoria, of the family Urocentrina.

Char. Free, no pedicle; tail awl-shaped; cilia absent from the body, but forming an anterior crown; mouth not spiral.

U. turbo (Pl. 25. fig. 14). Body hyaline, ovate, trilateral, tail one third the length of the body. Aquatic; length 1-430 to 1-290''.

BIBL. Ehr. *Infus.* p. 268.

UROCOC'CUS, Hassall.—A genus of Palmellaceæ (Confervoid Algæ), remarkable for the peduncular processes formed by the gelatinous coats of the cells. The cells are invested by a gelatinous coat or "membrane" (like that of GLŒOCAPSA), which is originally simple; but new gelatinous layers are successively produced on the immediate surface of the cell-contents; and as each new one is formed the preceding layer is ruptured on one side and partially thrown off, the cell with its new layer lying in the preceding layer as in a cup; by the repetition of this process the cup-like exuviæ accumulate, packed one within another so as to form a peduncle, the structure of which may be roughly compared to a pile of wooden washing-bowls or tea-cups standing one in another. When the cell-contents divide into two portions, the peduncles bifurcate (Pl. 3. fig. 7). The striæ indicating the successively shed coats are more or less distinct in different species, and probably in different conditions of the same. *U. Hookerianus* is represented in Pl. 3. fig. 7; *U. insignis* is very much larger; *U. Allmanni* and *U. cryptophila* are much alike, and neither presents the striæ. A green species is also described with the synonym (erroneous?) of *Chlorococcum murale*, Grev.

The mode of reproduction is unknown.

BIBL. Hassall, *Brit. Mar. Alg.* p. 322, pl. 80; A. Braun, *Verjüngung, &c.* (*Ray Soc. Vol.* 1853, p. 178); Rabenht. *Fl. Eur. Alg.* iii. p. 31.

UROGLAUCINE. — This substance, which was first detected by Heller, may be obtained by evaporating human urine with concentrated nitric acid (Pl. 9. fig. 20). Its true nature is unknown; but it is probably a product of the decomposition of the colouring-matter of the urine; it has perhaps some relation with indigo.

BIBL. Heller, *Archiv f. phys. Chemie und Mikrosk.*; Lehmann, *Phys. Chem.*; Funke, *Atlas, &c.*

UROGLE'NA, Ehr.—A supposed genus of Volvocineæ (Confervoid Algæ), consisting of a family of zoospore-like individuals arranged at the periphery of a membranous sphere, as in *Volvox,* but said to differ from that genus in having only one cilium, and also a basal prolongation or tail running toward the centre of the sphere. *U. volvox* is described as a sphere, 1-95'' in diameter, with yellowish corpuscles 1-1728'' long, exclusive of the tail, which is three or four times as long. Inhabiting bog-pools. We very much doubt whether it is distinct from VOLVOX.

BIBL. Ehr. *Infus.* p. 61.

UROLEP'TUS, Ehr.—A doubtful genus of Infusoria, of the family Colpodina.

They are either *Oxytrichæ* or *Spirostoma.*

Char. Eye-spot absent; no tongue-like process, nor proboscis; a tail present.

1. *U. piscis* (Pl. 25. fig. 15 *a*) = *Oxytricha caudata,* Duj. Body terete, subturbinate, gradually narrowed behind into a tail; internal granules green. Aquatic; length 1-288 to 1-144''.

2. *U. lamella* (Pl. 25. fig. 15 *b*). Body depressed, hyaline, linear-lanceolate, flat and very slender. Aquatic; length 1-216''.

BIBL. Ehrenberg, *Infus.* p. 358.

UROM'YCES, Lk.—A supposed genus of Uredinei (Coniomycetous Fungi), perhaps not properly separated from *Puccinia,* but distinguished from the ordinary state of that genus by the unilocular spores of the perfect fruit (see UREDINEI and PUCCINIA). The genus *Pileolaria,* Cast., does not appear to differ from *Uromyces* in any essential particular. The *Uromycetes* are rusts occurring upon leaves, presenting at least two forms of fructification (*spermogonia* have not yet been observed), viz., 1. *Uredo-fruits,* consisting of stylospores unaccompanied by paraphyses, which have been described as species of *Trichobasis,* Lév., and 2. the perfect fruit, resembling that of PUCCINIA, but with unilocular spores, unaccompanied by paraphyses. *U. ficariæ,* Lév. (*Uredo ficariæ,* Alb. & Schw.) is not uncommon on Ranunculaceæ, *U. appendiculatus,* Lk. (*Uredo appendiculosa,* Berk.), on various Leguminosæ.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. pp. 380, 382; Tulasne, *Ann. des Sc. Nat.* 4 sér. ii. pp. 145 & 185; Léveillé, *ibid.* 3 sér. viii. p. 370; De Bary, *Brandpilze,* p. 33.

URONE'MA, Duj.—A genus of Infusoria, = *Cyclidium*.

U. marina = *C. marina* (Pl. 25. fig. 16). Body colourless, semitransparent, nodular, and with four or five faint longitudinal ribs. Marine; length 1570″.

Bibl. Duj. *Infus.* p. 392; Clap. et Lach. *Etudes*, p. 271.

UROP'ODA, Latr.—A genus of Arachnida, of the order Acarina and family Gamacea.

Char. Palpi and rostrum inferior; dorsal shield consisting of a single, broad, circular or oval piece; legs nearly equal; body frequently with a caducous anal peduncle.

U. vegetans (Pl. 2. fig. 25).

Bibl. Dugès, *Ann. des Sc. Nat.* 2 sér. ii. 29; Gervais, *Walckenaer's Arachniden*, iii. 220.

UROSTY'LA, Ehr.—A genus of Infusoria = *Oxytricha*.

U. grandis = *O. urostyla* (Pl. 25. fig. 17). Semicylindrical, subclavate, rounded at the ends, anterior portion slightly thickened. Aquatic; length 1-144 to 1-96″.

Bibl. Ehr. *Infus.* p. 369; Clap. et Lach. *Etudes*, p. 142.

UROT'RICHA, Clap. et Lach.—A genus of Trachelina (Ciliate Infusoria).

Char. See Trachelina. One species, *U. farcta*, is known by its small size and long, single, saltatory cirrus.

Bibl. Clap. et Lach. *Etudes*, p. 314.

UR'TICA, L.—The genus to which the stinging-nettle belongs (see Stings).

US'NEA, Ach.—A genus of Parmeliaceæ (Gymnocarpous Lichens), with a somewhat crustaceous branched thallus, bearing peltate apothecia, which often have a ciliated margin. *U. barbata* is common on park-pales and old trees, *U. florida* and *plicata* in similar situations, mostly in mountainous regions; it is possible they are all forms of one species. The pendulous fibrillous thallus and ciliated apothecia of *U. barbata* are very characteristic.

Bibl. Hook. *Brit. Flor.* ii. pt. 1. p. 230; Schærer, *Enum. Crit.* p. 3.

USTILAGIN'EI.—A family of Coniomycetous Fungi related to the Uredinei, generally distinguished by their growing in the interior of the organs (especially the ovaries and anthers) of Flowering Plants, causing deformity, absorption of the internal tissue, and its replacement by a pulverulent substance consisting of the spores of the Fungi. In the earlier stages, the infected organ exhibits either a grumous mass, or an interwoven filamentous mycelium, from which acrogenous spores arise; finally the mycelium disappears, and a dark-coloured (often fœtid) powder remains, composed entirely of the spores, which are simple, or

Fig. 781.

Fig. 782.

Fig. 783.

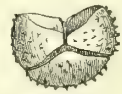


Fig. 784.

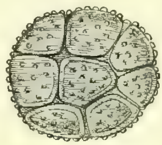
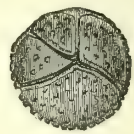


Fig. 785.



Thecaphora deformans.
Compound spores, entire and broken up.
Magnified 460 diameters.

more rarely compound (figs. 784, 785), *i. e.* several coherent within a common coat, at length free (figs. 781–783), smooth or unequally echinate or reticulated.

Bibl. Berk. *Brit. Flora* (art. *Uredo*); Tulasne, *Ann. des Sc. Nat.* 3 sér. vii. p. 5, 4 sér. ii. p. 157; De Bary, *Brandpilze*; Bauer and Banks, *in Curtis's Pract. Obs. on Brit. Grasses*, London, 1805; Unger, *Exanthem. Plant.*

USTILA'GO, Fries.—A genus of Ustilaginei (Coniomycetous Fungi), forming

Fig. 786.

Fig. 787.

Fig. 786. Ustilago Carbo, on oats. Nat. size.
Fig. 787. Ustilago Carbo, on barley. Nat. size.

smuts, infesting the ears of corn and other grasses, the ovaries and anthers of other Flowering Plants, and in some cases the leaves and stems of plants. The interior of the organ infested by them presents at first a grumous-mucous whitish mass, which grows at the expense of the tissue and juice of the infested organ, and is finally converted into a pulverulent mass of simple spores, mostly of deep colour, and with a smooth, spiny or reticulated surface.

The species growing upon leaves and stems occur on grasses, *e. g. U. longissima* (*Uredo longissima,* Sow.), *U. hypodytes* (*Ur. hypodytes*), and *U. grandis* (or *typhoides*); they form linear patches, ultimately containing smooth black spores.

The greater number, however, occur in

Fig. 788.

Portion of a spike of Maize infested with *Ustilago maidis.* Some of the lower grains perfect and mature; above these, female flowers with abortive ovaries. The projecting bodies are grains which have become deformed by the *Ustilago* developed within them.

the parts of flowers, especially of grasses—*Ust. Carbo* (*Uredo segetum,* Pers.), forming the blight called smut of corn, commonly infesting wheat, oats (fig. 786), barley (fig. 787), and other grasses, filling the ears with a black powder of smooth spores, about 1-5000″ in diameter in corn, sometimes about twice as large in the varieties attacking species of *Bromus.* The smut of maize (*U. maidis,* fig. 788) has minutely echinate spores, 1-2500″ in diameter.

Sedges are infested by *Ust. urceolarum* with dark brown and *Ust. olivacea* with olive-coloured spores (*Uredines,* Brit. Fl.). *Ust. antherarum,* growing in the anthers of Caryophyllaceæ, has violet-coloured spores. Many other species are described by Tulasne, several of which have occurred in Britain.

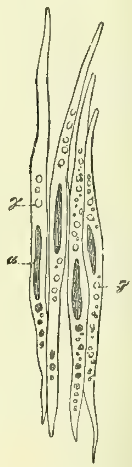
Bibl. Tulasne, *Ann. des Sc. Nat.* 3 sér. vii. p. 73, 4 sér. ii. p. 157; Berk. *Brit. Flor.* art. *Uredo*; *Ann. Nat. Hist.* 2 ser. v. p. 463.

UTE'RIA, Mich. See Thyrsoporella.

U'TERUS.—The substance of the uterus consists of longitudinal, transverse, and oblique unstriated muscular fibres, interwoven with imperfectly developed areolar tissue resembling that in the stroma of the ovary.

Three layers of the muscular fibres are described, but they are intimately connected. Those in the cervix are principally transverse or circular; and immediately beneath the mucous membrane at the mouth of the uterus, the transverse fibres form a sphincter.

Fig. 789.



Uterine muscular fibres, three weeks after parturition, treated with acetic acid. *a*, nuclei; γ, globules of fat.

Magnified 350 diameters.

The muscular fibres are from 1-600 to 1-400″ in length, fusiform, with elongate-oval nuclei, and very difficultly separable on account of the large amount of areolar tissue intermingled with them.

The epithelium is simple and ciliated. The mucous membrane of the body has no papillæ, but here and there some folds, and contains numerous tubular or uterine glands resembling the Lieberkühn's glands of the intestines, their cæcal ends being simple, bifurcate, or spiral, and consisting of a basement-membrane with cylinder-epithelium.

In the cervix are situated glandular depressions of the mucous membrane, which secrete a transparent tenacious

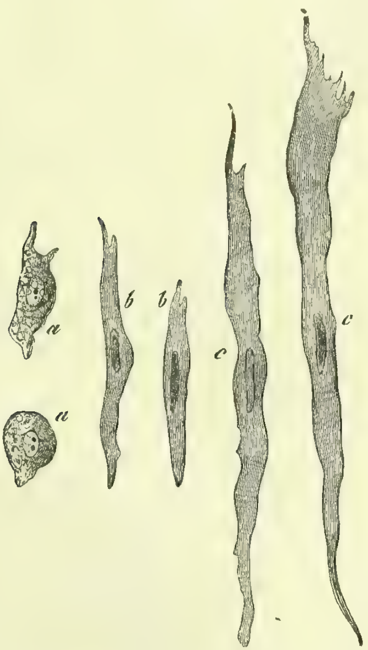
mucus; some of these are closed, and form the ovules of Naboth.

The lower third or half of the canal of the cervix contains papillæ covered with ciliated epithelium.

During pregnancy, the uterine elements, especially the muscular fibres, as also the vessels and probably the nerves, become enlarged and more numerous, from new formation (fig. 790).

All three of the coats of the veins of the pregnant uterus contain muscular fibres. After parturition, many of the muscular fibres undergo fatty degeneration, and become absorbed (fig. 789).

Fig. 790.



Muscular elements from a uterus at five months' gestation. *a*, formative cells; *b*, young; *c*, fully developed muscular fibres. Magnified 350 diameters.

BIBL. Kölliker, Mikr. *Anat.* ii.; Chrobak *in Stricker's Hum. & Comp. Hist.* iii. p. 474, tr. Power.

UVEL'LA, Bory, Ehr.—A genus of Infusoria, of the family Monadina.

Char. Corpuscles without an eye-spot, moving by means of one or two flagelliform filaments, or an anterior circle of cilia, and aggregated into spherical revolving clusters.

U. virescens (Pl. 25. fig. 18). Corpuscles ovate, rounded at each end, bright green. Aquatic; diameter of clusters 1-288", length of corpuscles 1-2016".

Dujardin regards the presence of the flagelliform filament as a character of the genus.

The life-cycle of a cercomonad.—One of the Uvellæ has been described by Dallinger and Drysdale. When mature it multiplies by fission for a period extending over from two to eight days. It then becomes peculiarly amœboid; two individuals coalesce, slowly increase in size, and become a lightly distended cyst. The cyst bursts, and incalculable hosts of excessively minute sporules are poured out, as if in a viscid fluid and densely packed; these are scattered, and slowly enlarging acquire flagella. They become active, attain rapidly the parent form, and once more increase by fission.

BIBL. Dallinger & Drysdale, *Mo. Mic. Jn.* 1873; Ehr. *Infus.* p. 19; Duj. *Infus.* p. 300.

UVIGERI'NA, D'Orb.—A genus of hyaline Foraminifera, near Polymorphina. Shell made up of three series of inflated chambers, alternating irregularly on an elongate spire, often ribbed; orifice central, round, tubular, and lipped. The triserial alternation passes sometimes into a biserial and even a uniserial growth (*Sagrina*, restricted). *Uvigerina* is world-wide in its distribution, and goes back to the Middle Tertiary Period.

U. pygmæa (Pl. 18. fig. 8).

BIBL. D'Orbigny, *Ann. Sc. Nat.* vii. 269; Carpenter, *Introd. For.* 169; Parker & Jones, *Phil. Trans.* clv. 363.

BIBL. That of the order.

VAC'UOLES.—Clear spaces in the protoplasm or sarcode of many Protista, especially in the Infusoria. They change their position in the individual, and should not be confounded with "contractile vesicles."

See INFUSORIA.

VAGINIC'OLA, Lamarck, Ehr.—A genus of Vorticellina, Ciliate Infusoria.

Char. Body sessile, in a membranous, urceolate, sessile sheath. See VORTICELLINA.

V. crystallina (Pl. 25. fig. 19) = *Cothurnia crystallina*. Sheath crystalline, urceolate, straight, internal granules green. Aquatic; length 1-216".

1 sp. only, *V. decumbens*, Berl.

BIBL. Ehr. *Infus.* p. 295; Clap. et Lach. *Etudes*, p. 126.

VAGINULI'NA, D'Orb.—A Stichostegian subgenus of *Nodosarina*, with oblique chambers.

V. badenensis, D'Orb. (Pl. 18. fig. 35).

BIBL. Williamson, *Rec. Foram.* 21 (*Dentalina*); Jones, Parker, and Brady, *Monogr. For. Crag.* 63.

VALKE'RIA, Flem.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Vesiculariadæ.

Char. Variously branched; cells oval, irregularly clustered; eight tentacles, but no gizzard. Three species.

BIBL. Johnst. *British Zooph.* p. 373; Gosse, *Mar. Zool.* ii. p. 20.

VALLISNE'RIA, Mich.—An aquatic genus of Angiospermous Flowering Plants, belonging to the family Hydrocharidaceæ. *V. spiralis*, a native of the South of Europe, occurring wild also in North America, India, &c., is commonly grown in jars for the sake of observing the ROTATION in the leaves. This plant is diœcious; and the specimens ordinarily found in cultivation are the pistillate forms, which often produce flowers, but the seeds, remaining unfertilized, never ripen; the plant increases rapidly, however, by runners, if in a healthy condition. We find it thrive well in any situation indoors near a window and not exposed to frost; but it attains a far larger size in water kept at a high temperature, as in *Victoria*-tanks in Botanic Gardens. It is necessary, when growing it in jars, not to keep too many or too large "snails" in the water, as they destroy the leaves. See ROTATION.

VALVULI'NA, D'Orb.—A genus of arenaceous Foraminifera.

Typically it has a triserial, three-sided, pyramidal shell, with three chambers in a turn of its spire and a valved or tongued aperture. The trifacial compression disappears in a common trochoid form, which becomes scale-like and flat. If the chambers fail to make a coil, an obliquely semioval shell is produced, with a broad oblique septal plane and a large valve, which bridges over the crescentic aperture with bars. The triangular form sometimes becomes Buliminoid; and often takes on a uniserial growth (*Clavulina*, restricted), either cylindric, tricarinate, or five-angled. Numerous forms, recent and fossil. *V. austriaca* (Pl. 18. f. 20).

BIBL. Parker & Jones, *Ann. N. H.* 3. v. 467; Carpenter, *Introd. For.* 146.

VAMPYREL'LA, Haeckel. A genus of Monera. See PROTISTA.

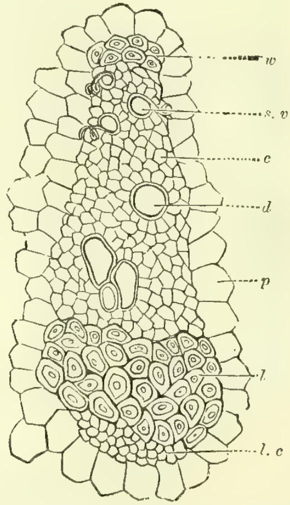
BIBL. Haeckel, *Qu. Mic. Jn.* 1869, p. 33.

VARIOLA'RIA, Pers.—A spurious genus of Lichens, founded upon imperfect forms of PERTUSARIA, &c.

BIBL. Hook. *Brit. Flor.* ii. pt. 1. p. 172; Schærer, *Enum. Crit.* p. 229.

VASCULAR BUNDLES.—This title is applied to the fibrous cords which form the ribs, veins, &c. of the leaves, petioles and other appendicular organs of all plants ranking above the Mosses, and which by their confluence and more considerable development constitute the wood of stems and trunks. The vascular bundles of petioles (fig. 660, page 721), &c., running into leaves to form their ribs, and lying imbedded in parenchyma, resemble the bundles which form the rudiments of wood of the stem itself. The bundles remain isolated as fibrous cords in the stems of the herbaceous Monocotyledons, or are only combined into a wood, in the Palms, &c., by the lignification of the cells of the parenchyma in which they are imbedded (fig. 461, p. 501). In the Dicotyledons, the rudimentary bundles are developed in a circle surrounding the pith (fig. 455, p. 487), and soon unite to form a tube of wood, with an external cambium layer and

Fig. 791.



Monocotyledon.

Transverse section of a fibro-vascular bundle of a Palm; the upper end is directed towards the centre of the stem. *w*, woody fibres resembling liber in structure; *s. v*, spiral vessels; *c*, cambium (*vasa propria*); *d*, ducts; *p*, parenchyma; *l*, liber; *l. c*, laticiferous canals. Magnified 150 diameters.

a true bark; and the cambium layer is the seat of renewed development of the vascular bundle in each successive year. On such

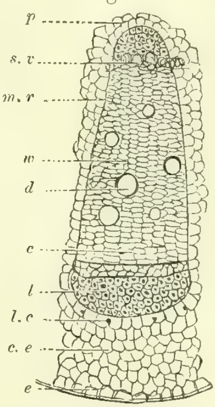
characters of growth, Schleiden founded a division of the vascular bundles into classes which are convenient in reference to microscopical investigations, and affixed tolerably perfect systematic characters to them.

In the higher Flowerless Plants, viz. Ferns, Equisetaceæ, &c., the vascular bundles are composed chiefly of ducts, surrounded by elongated tubular cells, almost devoid of secondary deposits, the whole enclosed by a layer of tolerably firm prosenchymatous wood-cells, especially developed in the Ferns. In the Ferns, the ducts are mostly of the kind called *scalariform* (fig. 664, page 722; Pl. 39. fig. 10), in the Equisetaceæ *annular* (fig. 661, page 722), in the Lycopodiaceæ *spiral* (fig. 659, page 721; Pl. 39. figs. 11 & 12). They are variously arranged in the different orders, but agree in the mode of development, namely in growing only at the end next the *punctum vegetationis*, in proportion to the elongation of the stem and the evolution of leaves. Hence Schleiden calls them *simultaneous bundles*; their various elements—ducts, tubular and prosenchymatous cells—being formed simultaneously.

In the Monocotyledons, where the vascular bundles occur isolated, they originate in the *punctum vegetationis*, and are developed with the growth of the stem, outwards and upwards into the leaves, and outwards and downwards towards the permanent circumference of the stem, old and new bundles crossing each other in a more or less complicated manner (fig. 461, page 501). Here (fig. 791) the first trace of the vascular bundle consists of spiral vessels, followed on the outer side by spiral, annular, or reticulated ducts; next comes a collection of elongated tubular cells of delicate structure (*vasa propria*), and in the outer part, at first, a *cambium* region, which is gradually converted into prosenchymatous woody structure having the character of LIBER-cells. In this case, the development is not only gradual from the *punctum vegetationis* outward, but the inner side of each bundle is perfected first, and the conversion of the outer part into wood occupies a whole season of growth. Hence these are entitled *progressive bundles*; but as no new development occurs in these in successive seasons, they are further distinguished from those of the Dicotyledons as *definite* bundles. The structure of the vascular bundles of Monocotyledons is very well seen, in different characteristic conditions, in vertical and horizontal sections of the stems of the white lily, of the large grasses, rhizomes of sedges and rushes—affording well-developed examples in herbaceous structures—of the bamboo (an arborescent grass), of the common cane or the "partridge cane" (both species of Palms), where the bundles are connected by lignified parenchyma. In leaves of bulbous Monocotyledons, &c., the bundles consist chiefly of spiral vessels; in the palms, bananas, &c., the woody fibre extends also into the ribs of the foliaceous organs.

In the Dicotyledons, the bundles of the stem appear first as a circle of cords composed of spiral vessels, around the pith, outside which larger vessels and ducts, and subsequently woody fibre or wood-cells are developed, passing into the elongated prosenchymatous liber (fig. 792). The development of the successive regions is *progressive* during the first season; but here the *cambium* layer remains capable of renewed activity, and a new layer of wood (and of liber) is added on the outside of the bundle in each successive season; hence these bundles are distinguished as *indefinite*. These may be observed in sections and young shoots of any common tree (figs. 455 & 457, pages 487 & 488).

Fig. 792.



Dicotyledon.

Transverse section of a fibro-vascular bundle of a Melon stem; the upper end next the centre of the stem. *p*, pith; *s. v*, spiral vessels; *m. r*, medullary rays; *w*, wood; *d*, pitted ducts; *c*, cambium; *l*, liber; *l. c*, laticiferous canals; *c. e*, cellular envelope of the bark; *e*, epidermis. Magnified 50 diameters.

Infinite variety of modification occurs in the character and arrangement of the vascular bundles within the limits above laid

down, or very slightly overstepping them. A few remarkable cases may be mentioned here; in the Orobanchaceæ (parasites) no spiral vessels occur in the vascular bundles forming the wood; in *Victoria regia* the isolated bundles are composed of spiral vessels without any prosenchymatous wood-cells; other peculiarities, influencing more especially the characters of WOOD, are given under that article. Vasculose, the substance of which vessels are formed, is insoluble in hydrochloric acid and sulphuric acid and in copper solutions, but is soluble in boiling caustic potash. (See also CAMBIUM and MEDULLA.)

BIBL. Henfrey, *Elem. Course* (Masters); Bentley, *Man. Botany*; and works on *Structural Botany*; *Qu. Mic. Jn.* 1870, p. 204; *Mo. Mic. Jn.* iii. 1870.

VAUCHE'RIA, D.C.—An important and to the microscopist a most interesting genus of Siphonaceæ (Confervoid Algæ), consisting of green filamentous plants growing in fresh and salt water, and on damp ground, characterized by the continuity of the cavity throughout the branched tubular filament (sometimes several inches long) of which each plant is composed, and by the modes of reproduction, both by gonidia and by spores. *Vaucheriæ* may be gathered on damp borders in every garden, or by the sides of ditches, where they form fine silky green tufts; they are very variable in form and size, so that the specific distinctions heretofore laid down appear to be worth little. The ordinarily occurring species presents itself as a tubular cell of comparatively gigantic dimensions, containing more or less protoplasm, coloured by chlorophyll in the form of minute granules applied upon the wall or occupying more or less of the cavity. The green granules may be seen to lie imbedded in a colourless protoplasm at the inner surface of the cellulose wall; and it is curious to observe, when the filament is accidentally or intentionally ruptured, that the green granules which may escape are contained in a mucous investment, which soon rounds itself into a globular body, of size proportionate to the quantity of green granules extruded; these globules sometimes even exhibit a slight rolling movement, but they appear ultimately to decay. Such globules sometimes occur inside the filaments, when the growth is unhealthy; and Itzigsohn calls them *spermatospheres*, stating that they produce spermatozoids. This, like all this author's observations, requires confirmation.

If the *Vaucheria*-filaments are gathered at a favourable epoch, or if they are cultivated in a vessel of water well exposed to light, the blind ends of the filaments (or rather of the ramifications of the filament) are found very densely filled with green contents, appearing almost black; and if these ends are watched early in the morning, a remarkable series of phenomena is observed in them. The ends of the filaments about to produce gonidia are found swollen into a slightly clavate form, the green contents of the "club" part from the general contents of the filament, leaving a transparent space (fig. 793); then, having as it were acquired a definite independence, the isolated mass returns so as to fill up the transverse light space, but does not again coalesce with the lower mass of contents. Next, a light space is observed between the surface of the terminal body of contents and the cellulose

Fig. 793.

Fig. 794.

Vaucheria Ungeri.

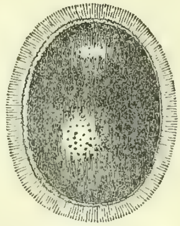
Fig. 793. End of a filament in which a gonidium is being developed.
Fig. 794. Gonidium escaping from the filament.

Magnified 50 diameters.

wall surrounding it; and the latter soon gives away at the apex, forming a passage for the escape of the contents. This mass of contents is now clearly recognizable as the *gonidium* or zoospore; it gradually extricates itself from the tube, with a rotatory motion around its own axis, and it exhibits a remarkable elasticity of structure, giving way and altering its form (fig. 794) to squeeze through the narrow orifice of escape; sometimes it becomes "pinched" in this process into two independent gonidia of half the usual size. As soon as it has perfectly emerged, it assumes an elliptical form, increases much in size, and is seen to be covered with innumerable vibratile cilia

(fig. 796), arising from its gelatinous (protoplasmic) coat (these are rendered much more distinct by applying tincture of

Fig. 795. Fig. 796.



Vaucheria Ungeri.

Fig. 795. End of the filament from which the gonidium has escaped. Magnified 50 diameters.

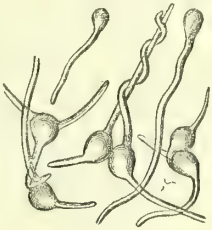
Fig. 796. Gonidium which has been treated with iodine and dried between two slips of glass, showing the cilia very clearly. Magnified 110 diameters.

iodine): no cellulose membrane exists at this time; and the gonidium swims about actively in the water, revolving on its long axis. The large number of cilia existing on this gonidium distinguish it remarkably from all others; but we are inclined to believe that there is a nearer relationship than appears at first sight. The green substance at the surface of the gonidium presents a peculiar granular or globular appearance; and it appears not far-fetched to regard this body as composed of a densely combined family of ordinary two- or four-ciliated zoospores, such as would be formed by the swarming-spores of *Hydrodictyon* if they remained in their primitive crowded condition. This, however, is a point requiring further examination. The end of the tube from which the gonidium has escaped appears as a hyaline sac (fig. 795), which soon decays down to the point where the contents parted, where a septum, now closing the tube, is developed.

After swimming about for some time, from one to several hours (usually about two), the gonidium falls to the bottom of the vessel, its cilia disappear, and it assumes a spherical form, acquiring very soon a distinct cellulose coat; after this it soon germinates by pushing out one or more tubular processes (fig. 797), which grow up into filaments like the parent. Sometimes the gonidium cannot make its escape; sometimes half of it escapes and becomes pinched off, the other half being left behind: in these cases, the arrested body, or the remaining portion of the divided one, germinates *in situ* (fig. 798).

It should be mentioned that the contents of the vegetative filaments have a remarkable tenacity of life; for if the tube is slightly

Fig. 797. Fig. 798.



Vaucheria Ungeri.

Fig. 797. Gonidia germinating. Magnified about 15 diameters.

Fig. 798. Filament with gonidia germinating in the parent tube; the left-hand figure, half a divided gonidium. Magnified 25 diameters.

injured at any point, the primordial utricle commonly retracts from the wound, and secretes a cellulose layer on its surface, shutting off the injured part. Filaments are sometimes met with having several living regions of this kind, shooting out into branches, separated from each other by dead, empty lengths of the filament.

Besides the vegetative reproduction above described, the *Vaucheriæ* are reproduced by spores formed by the concurrence of two distinct kinds of reproductive organs. Filaments growing on damp ground ordinarily exhibit lateral organs of two kinds, associated together, but variously grouped and collected in varying numbers at particular points, apparently according to external conditions. The larger kind of organ appears first as a pouch-like process, which expands into a squat, flask-shaped body, stalked or sessile, the neck of which is gradually turned over in the development, until it projects at one side, the form then somewhat resembling that of a bird's head (or a chemist's glass retort cut off short at the neck) (Pl. 45. fig. 12 A, B, *s*). Near this, on the main filament, or on a common pedicel with one or more of the bird's-head organs, is developed another organ, at first straight and tubular, but soon curving over into the form of a hook or scroll, without, however, expanding (Pl. 45. fig. 12 A, B, *a*). The expanded part of the bird's-head organ (or

sporangium) becomes filled with dense green granular matter, and cut off by a septum from the main filament. The upper part of the "hook" is likewise cut off by a septum; and the contents of the apical cell thus formed are of a light colour, and soon lose most of the chlorophyll. From the association of these two kinds of organ, and the production of spores in the sporanges, it was supposed, as long ago as in Vaucher's time, that they represented sexual organs. Vaucher thought the "hooks" discharged a kind of pollen to fertilize the sporanges. Other algologists, especially Nägeli, supposed or asserted that a conjugation took place between them (like that in *Spirogyra*), —a view more or less favourably received until a few years since, when Karsten asserted that he had actually observed it in all its details. But Pringsheim long since published a very complete and certainly more trustworthy account of the development of these structures, in which he denies the conjugation, but asserts that the "hook" is an *antheridium*, and that when mature it bursts at the apex and discharges biciliated spermatozoids resembling those of *Fucus*, which enter the simultaneously opened neck of the sporange and fertilize its granular contents. The contents become isolated from the wall, secrete a proper coat, and form a free cell (spore) lying in the sporange, its granular matter gradually losing the green colour and becoming brown (Pl. 45. fig. 12 c). Two coats, at least, are developed; and the spore ultimately escapes by the decay of the parent filament and sporange. According to Pringsheim, about three months elapse before germination, in which process the outer spore-coat splits, and the inner grows out into a tube, forming the basis of a new ramification of the *Vaucheria*-filament.

In the systematic works on Algology, numerous species of aquatic and land *Vaucheriæ* are described; but we agree with Thuret in believing that the characters by which most of the forms are distinguished are unessential, therefore we omit any synopsis of them. Even *V. racemosa*, Decaisne, appears merely an extreme of the kind of development producing *V. geminata.* Thuret proposes the name *V. Ungeri*, to include all but *V. racemosa*; Hassall suppresses the name *V. clavata*, as indicating a form common to all the species, of which he describes a large number. We do not find any thing sufficiently distinctive in the characters of the marine species cited by Harvey.

The admirable essay of Unger should be consulted by those studying the gonidial reproduction.

Bibl. Vaucher, *Conferves d'eau douce* (Ectosperma); Hassall, *Brit. Fr. Alg.*; Harvey, *Brit. Mar. Alg.* p. 195; Unger, *Nova Acta*, xiii. p. 11, *Die Pflanze im Mom. der Thierwerdung*, Vienna, 1843; Decaisne, *Ann. des Sc. Nat.* 2 sér. xvii. p. 430; Thuret, *ibid.* xix. p. 266; Karsten, *Bot. Zeitung*, x. p. 85 (1852), xv. p. 1; Pringsh. *Ber. Berl. Akad.* March 1855; *Ann. Nat. Hist.* 2 ser. xv. p. 346; Alex. Braun, *Verjüngung* (*Ray Soc. Vol.* 1853, passim), *Alg. unicell.* (1855) pp. 8, 105; Nägeli, *Neues Algensyst.* p. 175 pl. 4; Itzigsohn, *Bot. Zeit.* xi. p. 225 (1853); Dippel, *Flora*, 1856, p. 481; Rabenht. *Fl. Eur. Alg.* iii. p. 267.

VEGETABLE IVORY.—This substance consists of the seeds of the Palm called *Phytelephas macrocarpa*, composed of a large round mass of bony Albumen, in which a small embryo is imbedded. Slices of this ivory-like albumen, placed under the microscope, afford very beautiful examples of vegetable cells with the cavities almost obliterated by Secondary deposits (Pl. 38. fig. 23).

VEIN.—Veins of the human body differ from arteries in possessing thinner walls, less elastic and muscular tissue, and a stronger tunica adventitia. There are five histological elements to be considered, viz. the epithelial or internal layer, the internal elastic membrane, the fibrous tunic, the muscular fibres, and the tunica adventitia, besides the valves of the veins.

Epithelial layer consists of cells which, when compared with the corresponding structures of Arteries, present a more polygonal and less distinctly fusiform shape, and are consequently shorter and broader. Their size varies in different regions of the body.

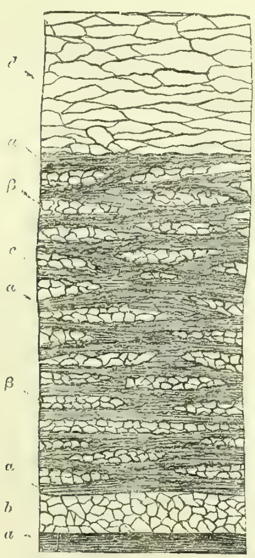
Internal elastic membrane.—This is a delicate and rather loose network of fibres, which for the most part run in a longitudinal direction and but rarely form a fenestrated elastic tunic; for this only occurs in large venous trunks. The membrane never acquires the strength and size it attains in the arteries. In the iliac and crural veins this coat appears in some places to be split into two laminæ which intercommunicate by means of fine elastic fibrils, and the space between is occupied by a

fibrous connective tissue containing longitudinally and transversely arranged short fusiform cells.

The *internal longitudinal-fibrous tunic* is situated between the epithelial layer and the internal elastic membrane, as in the arteries, but is developed to a much less extent. In some veins it is almost wanting, as in those of the neck and axilla, the vena cava, and the mesenteric, portal, and pulmonary veins. In the popliteal vein, on the contrary, where it is very thick and presents small elevations and transverse rugæ to the eye, its structure is essentially like that of the corresponding layer in the arteries, with the exception that in many parts numerous muscular fibres are present in the venous structure. Thus the crural vein presents small bundles of longitudinal muscular fibres between the laminæ of its elastic inner coat; and the popliteal possesses in the same layer an internal longitudinal and an external transverse layer of muscular fibres.

Muscular fibres.—In accordance with the presence or absence of muscular fibres in the walls of the veins, these vessels are

Fig. 799.



Longitudinal section of the vena cava inferior, near the liver. *a*, inner coat; *b*, middle coat without muscular fibres; *c*, inner layer of the outer coat—*α*, its longitudinal muscles; *β*, its transverse areolar elements; *d*, outer portion of the outer coat, without muscles. Magnified 30 diameters.

divided into the muscular and the non-muscular. To the former belong the veins of the pia and dura mater, the veins of Breschet in the bones, the veins of the retina, the lower portions of the veins of the trunk opening into the vena cava superior, the external and internal jugular veins, and the subclavian veins. The muscular veins may be divided into three groups:—1. Veins with longitudinal muscles, as those of the pregnant uterus. 2. Veins with an internal layer of circularly and an external layer of longitudinally arranged muscular fibres, the axillary veins for instance. 3. Veins with an internal and external longitudinal and middle transverse layer of muscular fibres, such as the iliac and popliteal veins. 4. Veins with circular muscular fibres, such as the smaller veins of the neck and internal mammary vein. The arrangement of muscular fibres varies in the same region. As regards the proportional strength of the muscular coat, the following veins are placed in order of diminishing muscular power:—the veins of the lower extremities, those of the abdominal viscera and upper extremity, and, finally, those of the thorax and neck.

The *tunica adventitia* consists of bundles of decussating fibrils, the direction of which is for the most part longitudinal. As a general rule their diameter increases with that of the vessel; but there are many exceptions. This layer is thicker in the veins than in the arteries; moreover it contains but a small amount of elastic fibres, and a certain amount of longitudinal muscular fibres in some veins. Nevertheless the limits between the layers of muscular and elastic fibres are never well defined.

The *valves* of veins cannot be regarded as true duplications of the internal tunics. The elastic, finely fibrillated internal membrane covers only the convex surface of the valves; and the proper substance of the valve is composed of finely fibrillated connective tissue, with stellate and fusiform cells.

Bibl. Eberth *in Stricker's Human & Comp. Hist., Syd. Soc. tr.* Power, i. p. 275.

VEINS of Plants. — The name commonly applied to the ramifications of the Vascular bundles, forming the ribs of leaves and similar organs.

VENILI'NA, Gümbel. See Textularia.

Bibl. Gümbel, *Tr. Munich Acad.* cl. 2. x. 648.

VER'MES = Annuloida (without the

Echinodermata) and the Annulosa belonging to the classes Gephyrea, Annelida, Chætognatha.

VERMICULA'RIA, Fr.—A genus of Sphæronemei (Coniomycetous Fungi), but seemingly stylosporous states of Sphæriacei, most of the species being included under *Sphæria* in the British Flora. They grow on decaying stalks, leaves, or wood.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 274, &c., *Ann. Nat. Hist.* 2 ser. v. p. 378; Fries, *Summa Veg.* p. 419.

VERMILION, or bisulphuret of mercury, is used as a pigment for injecting. It should be in a finely divided state, in which it is best obtained by levigation, and should not exhibit any white crystalline particles when examined as an opaque object.

See INJECTION.

VERNEUILI'NA, D'Orb. See TEXTULARIA.

VERRUCA'RIA, Pers.—A genus of Verrucarieæ (Angiocarpous Lichens), containing numerous species having a crustaceous or cartilagineo-membranous thallus growing upon and adherent to the bark of trees or stones; named from the wart-like processes corresponding to the perithecia, which open by a pore at the surface. The perithecia have a black rind, enclosing either the whole or the upper half of the nucleus. The spermogonia much resemble the perithecia, only they are much smaller; they occur either scattered among the perithecia, or collected towards the margins of the thallus.

BIBL. Hook. *Brit. Flor.* ii. pt. 1. p. 152; Leighton, *Brit. Angioc. Lich.* p. 35; Schærer, *Enum. crit.* p. 213; Tulasne, *Ann. des Sc. Nat.* 3 sér. xvii. p. 215, pl. 3.

VERRUCARIE'Æ.—A family of Angiocarpous or closed-fruited Lichens, characterized by rounded apothecia, closed by a special *perithecium*, perforated by a contiguous pore, and containing a somewhat hyaline, gelatinous, dissolving nucleus.

VERTEBRALI'NA, D'Orb.—A genus of porcellaneous Foraminifera, near *Miliola*.

Char. Shell free, regular, greatly compressed, mostly inequilateral, more convex on one side than on the other, suborbicular or elongate; spire embracing in the young state only, afterwards straight; *chambers* in the spire, two or three; *orifice* a large patulous aperture along the septal plane. See ARTICULINA and RENULINA.

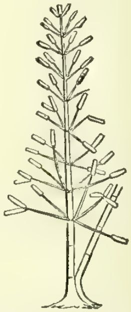
One recent British species:

V. striata (Pl. 18. fig. 10).

BIBL. Williamson, *Rec. For.* 89; Carpenter, *Introd. For.* 72.

VERTICIL'LIUM, Nees.—A genus of Mucedines (Hyphomycetous Fungi), distinguished from *Botrytis* (under which it is included, with *Acrostalagmus*, by Fries) chiefly by the verticillate arrangement of the sporiferous branches. A number of species are described; but from the observations of Hoffmann and Bail on the germination of *Trichothecium*, this genus represents only one form of the plants belonging to other genera,—*V. ruberrimum*, Bonorden (*Botrytis verticilloides*, Corda, which Hoffmann regards as identical with *Acrostalagmus parasitans* and *cinnabarinus*), having been raised from the spores of *Trichothecium roseum*, and its "spores" being barren (see TRICHOTHECIUM). Berkeley and Broome describe and figure several new species.

Fig. 800.



Verticillium cylindrosporum. Magnified 200 diameters.

BIBL. *Ann. Nat. Hist.* 2 ser. vii. p. 101, pl. 7. figs. 15–18; Fries, *Summa Veg.* (*Botrytis*), p. 491.

See also TRICHOTHECIUM.

VESICULA'RIA, Thomps.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Vesiculariadæ.

V. spinosa, general on the sea-shore.

BIBL. Thompson, *Zool. Illustr.* p. 98; Johnston, *Brit. Zooph.* p. 370.

VESICULARI'ADÆ.—A family of Infundibulate Ctenostomatous Polyzoa.

Char. Polypidom plant-like, horny, tubular; cells free, deciduous, the ends flexible and invertile. Genera:

1. *Serialaria* (*Amathia*). Shoots slender, filiform, erect, branched; cells tubular, adherent, uniserial and unilateral, rows interrupted by blank intervals; tentacles eight.

2. *Vesicularia.* Shoots branched, jointed; cells oval, distinct, uniserial and unilateral; eight tentacles and a gizzard.

3. *Valkeria.* Variously branched; cells oval, irregularly clustered; eight tentacles, no gizzard.

4. *Mimosella.* Variously branched; cells ovate, in two rows, opposite, jointed at the base; eight tentacles and a gizzard.

5. *Avenella.* Filiform, creeping, nearly simple; cells large, solitary, scattered, in one row, slightly contracted at the top, curved;

twenty to twenty-four tentacles, and a small gizzard.

6. *Nolella.* Cells erect, subcylindrical, crowded on tubes which form an undefined incrusting mat; tentacles eighteen.

7. *Bowerbankia* (Pl. 43. fig. 19). Matted and creeping, or erect and irregularly branched; cells tubular, densely clustered; tentacles eight to ten, and a strong gizzard.

8. *Farrella.* As *Bowerbankia,* but tentacles twelve to thirty, and no gizzard.

9. *Anguinella.* Branched palmately, one tube springing from another, largely composed of mud; animals with twelve tentacles and no gizzard.

BIBL. Johnston, *Brit. Zooph.* p. 367; Gosse, *Mar. Zool.* ii. p. 19.

VES'PA, Linn.—*Vespa vulgaris,* the wasp, and *V. crabro,* the hornet, are readily accessible insects for the examination of the sting (STING).

VESSELS OF PLANTS.—This name was applied by the earlier observers to various elongated tubular structures of vegetable tissues, from an idea that they corresponded with the vessels of animals; and the name is still retained. The *spiral, annular,* &c. vessels are described under SPIRAL STRUCTURES. The term *vessel* is now generally contrasted with DUCT, to indicate a single long tubular cell, or row of confluent elongated cells, with *spiral* secondary deposits upon their walls, in contradistinction to a canal formed of a row of cells with *pitted* secondary deposits, applied end to end and confluent. The LATICIFEROUS tubes are sometimes called laticiferous or milk vessels.

VIBRAC'ULA are long bristle-shaped organs, attached to the cells of most species of Polyzoa. Each springs from a cup-like base that contains the muscular fibres, which move it in a sweeping direction over the surface of the polyzoarium. See POLYZOA.

VIB'RIO, Müll.—A genus forming the type of the family VIBRIONIA, Infusoria of authors, but part of which we have provisionally placed in the Oscillatoriaceæ (Confervoid Algæ).

Char. Filiform, more or less distinctly jointed from imperfect division; movement undulatory, like that of a serpent.

These filamentous bodies are extremely minute; their simple structure is best seen when they are dried.

V. subtilis (Pl. 3. fig. 18). Filaments colourless, elongate, hyaline, straight, distinctly jointed, motile vibrations very slight and not perceptibly altering their form. Aquatic, in pools; length reaching 1-430″; breadth 1-24000″. Probably an *Oscillatoria.*

V. rugula (Pl. 3. fig. 19). Filaments hyaline, distinctly jointed, very tortuous when in motion. In decomposing infusions; breadth 1-12000″.

V. prolifer (Pl. 3. fig. 20). Filaments short, hyaline, distinctly jointed, tortuous in their slow motion. In decomposing infusions; length 1-9200 to 1-1150″; breadth 1-9200″.

V. bacillus (Pl. 3. fig. 21). Filaments elongate, hyaline, joints sometimes distinct only after drying, flexuous in their slow motion; length 1-288″; breadth 1-1700″.

V. lineola, V. tremulans, and *V. serpens* are still more evidently algæ.

BIBL. Ehr. *Infus.* p. 77; Duj. *Infus.* p. 216; Rabenht. *Fl. Eur. Alg.* iii. p. 71.

VIBRIO'NIA.—A family of Infusoria, according to the classifications of Ehrenberg and Dujardin, but which appear, at all events in part, to be Algæ (OSCILLATORIACEÆ).

Char. Active, filiform, extremely minute, colourless, jointed bodies, of obscure organization, and without visible locomotive organs (except *Bacterium?*); straight, or spirally coiled, multiplied by division at the joints.

These organisms form some of the most minute which the microscopist is called upon to examine; and it is with the greatest difficulty that their structure can be made out. But although, in the ordinary method of examination, structure is invisible, yet by allowing them to dry spontaneously on a slide, or adding solution of iodine to them in the wet state or when dried, it can be distinctly seen that they are composed of minute joints, resembling very minute, colourless, Oscillatoriaceous Confervæ. When treated with potash, they are unacted upon, although the minute monads with which they are invariably accompanied are burst and dissolved. Nor have we succeeded in colouring them by Millon's or Pettenkofer's test, although their minute size is such that the magnifying power used to render them visible would so dilute the colour, by diffusing it over a large surface, that it is difficult to speak positively upon this point. They are propagated by the formation of new joints, and subsequent separation at one of the articulations. They are almost

invariably the first organisms found in decaying and putrefying organic matters, especially animal. When treated with iodine and then sulphuric acid, their jointed structure is rendered very distinct; and it appears that they are composed of two parts, an outer portion which seems pale or but slightly coloured, and an inner which becomes very dark; but the tints cannot be distinguished with certainty: they appear purplish or reddish-purple brown, quite different from the surrounding infusoria when thus treated.

Probably some of the *Vibriones* are but the earlier stages of other algæ; but what these algæ are is unknown.

The motion of these minute bodies would seem to indicate that some are furnished with cilia; but in others it is evidently produced by general contractility. M. Dujardin thinks, however, that he has sometimes seen a flagelliform filament analogous to that of the Monadina, or rather undulating helically; and Ehrenberg describes a cilium or flagelliform filament in one *Bacterium*. Our own repeated observations, made in such a manner (see CILIA) as will detect cilia with ease when present, or at least in any part where they have hitherto been found certainly, have failed to detect them in the Vibrionia (excluding *Bacterium*, which is doubtfully referred to this family).

We have included the genera *Bacterium* and *Vibrio* among the OSCILLATORIACEÆ, but the relations are still somewhat obscure; and this is even more the case with *Spirillum* and the rest, which are excluded there. We think it advisable, therefore, to add here a table of the genera according to the views of those who regard them as Infusoria, or at all events as a distinct family. More details are given under the respective heads.

Filament straight.	Inflexible	1. *Bacterium*.
	Flexible like a serpent	2. *Vibrio*.
Filament spiral.	Spiral helical	3. *Spirillum* (*Spirochæta*)
	Spiral flat, like a watch-spring	4. *Spirodiscus*.

They are best preserved by allowing them to dry spontaneously on the slide.

Fig. 801.

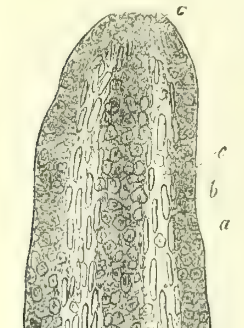


Fig. 802.

Fig. 801. Intestinal villus of a kitten, free from epithelium, and after treatment with acetic acid: *a*, boundary of villus; *b*, subjacent nuclei; *c*, nuclei of the muscular fibres; *d*, roundish nuclei in the middle of the villus. Magnified 350 diameters.

Fig. 802. *A*, magnified 75 diameters. Two villi with their epithelium, from a rabbit: *a*, epithelium; *b*, parenchyma. *B*, magnified 300 diameters. A row of detached epithelial cells. *a*, membrane separated by water. *C*, magnified 350 diameters. Detached epithelial cells. *a* with, *b* without the separated membrane; *c*, surface view of some epithelial cells.

For *Vibrio tritici* see Anguillula *tritici*.

Bibl. Ehr. *Infus.* p. 73; Duj. *Infus.* p. 209; Oscar Grimm, *Schultz's Archiv*, 1872.

VICTOREL'LA, Kent. — A genus of Polyzoa.

Bibl. Kent, *Qu. Mic. Jn.* 1870, p. 31.

VILLI.—These are minute folds or prolongations of the mucous membrane of the small intestines. They are most numerous in the jejunum and ilium—in the former conical and flattened, sometimes plate-like, cylindrical, club-shaped or filiform, whilst in the latter they are broader and flattened.

The villi form solid processes of the mucous membrane, consisting of areolar tissue without elastic elements, but abounding in roundish nuclei, containing also blood-vessels, lymphatics, and unstriated muscular fibres. See Intestine for minute anatomy.

The villi are exceedingly vascular, and form beautiful microscopic objects when

Fig. 803.

Fig. 803. Two villi from a calf, without epithelium, and containing each a lacteal vessel; after treatment with dilute solution of soda. Magnified 350 diameters.

injected; exhibiting a network of capillaries with rounded or elongate meshes.

Each villus contains a lacteal, the origin of which commences either in a single cæcal dilatation, or in a network of branches.

Fig. 804.

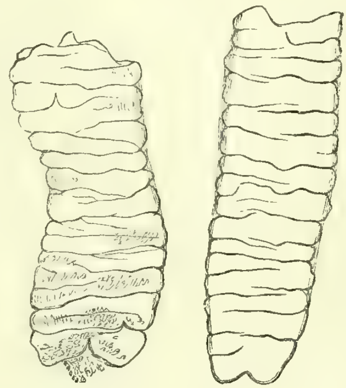


Fig. 804. Two contracted villi, from a cat. Magnified 60 diameters.

The muscular fibres form a thin layer, not very distinct in man, surrounding the lacteals, and capable of greatly contracting or shortening the villi.

The epithelial cells are intimately connected with each other, but easily detached from the villi, often in groups or rows. When acted upon by water, the cell-membrane at the surface is separated, leaving a clear space between the granular cell-contents and the former.

Bibl. Kölliker, *Mikrosk. Anat.* ii.

VINCA, L.—The generic name of the garden plants called Periwinkles; interesting to microscopists on account of the striated liber-fibres (Pl. 39. fig. 30). (See Spiral Structures, p. 723.)

VINE-FUNGUS. — The vine-mildew, *Oidium Tuckeri*, Berk., which has in recent years caused such extensive destruction, has formed a subject of investigation for most of the principal mycologists; and, notwithstanding that its natural history is not yet wholly cleared up, many interesting points have been discovered. As it ordinarily appears, it forms a white and very delicate cottony layer upon the leaves, young shoots, and fruit of the vine, soon causing a production of brown spots upon the green structures, and subsequently a hardening and a destruction of the vitality of the surface. Under the microscope, the white substance is seen to be composed of delicate

ramified filaments, creeping horizontally over the surface, and, when the plant is much developed, forming a dense interlacement. The horizontal filaments exhibit few septa, these occurring at the points of branching, and they do not penetrate into the interior of the epidermal layer; here and there, however, they are found fixed to the epidermis by a more or less developed organ of attachment, consisting of a disk or lobed expansion (comparable roughly to the so-called "root" of some of the Fucoid Algæ), which adheres firmly to the cuticle, and, when removed, leaves a brownish scar behind. The destructive effect of the Fungus seems to arise from its arresting the development of the epidermis, by binding its structures together, and excluding the surface from the influence of the air, since when young berries are invaded, the internal development proceeds, and, the sphacelated epidermis preventing the natural expansion, the grapes burst and rot. [In this case, species of *Botrytis*, &c. appear upon the decomposing pulp, as on all similar substances; and these must be distinguished from the proper mildew.] When full-grown leaves are affected to a moderate extent, the vitality is often only partially affected, causing a laxity of the tissue, and more or less fading of the green colour, without inevitable decay.

When the mildew is observed with a low magnifier, its surface exhibits a mealy appearance, arising from minute bead-like or pearly shining bodies of oval form; and the application of sufficient power shows that the horizontal filaments bear numerous erect branches or pedicels, consisting of short-jointed filaments (Pl. 20. fig. 8), the terminal cells of which (or the two last) are elliptical and expanded. These terminal cells are soon matured and then fall off; vast numbers of them are produced, and are found lying upon the surface among the creeping filaments, where they quickly germinate (Pl. 20. fig. 9) and produce new ramifications of mycelium. The fungus, as thus described, constitutes the *Oidium* proper; and the deciduous terminal cells form the so-called *spores*. But the history of the development of the mildew does not cease here.

In the first place, the detached 'spores' do not always produce a filament as represented in fig. 9; some of them present, while still attached, a kind of segmentation of the protoplasmic contents (fig. 10); and detached examples are found filled with minute 'sporules' of elongated-elliptical form. These minute 'sporules' are either discharged by a dehiscence of the 'spore' (fig. 11), and then germinate, or sometimes they germinate *in situ* and send out slender filaments through the walls of the spore. We have found also that the large filaments produced by the simple large 'spore' (fig. 9) do not always at once form a regular mycelium, but sometimes give rise to slender pedicels, terminating in a point bearing minute solitary corpuscles of about the size and form of the 'sporules' above described, and resembling the *spermatia* of many of the higher Fungi.

In addition to this, we have sometimes observed those 'spores' which produce the 'sporules' in their interior, with their outer membrane finely punctate; and in very rare cases this form of fruit was not composed of a single terminal cell, but presented indications of cross septa, as if two or more cells of the summit of the pedicel were confluent into one sac; here the punctation of the surface was very strongly marked.

Thus far we depend upon our own observations; but Mohl, Tulasne, and others describe a still more highly developed fruit than that last noticed: they have found the terminal body, producing 'sporules,' with a distinct cellular coat (Pl. 20. fig. 12), from which the sporules are discharged by a terminal dehiscence. Mohl found this body, very rarely, of spherical form. We have never seen this cellular coat; in the cases we have met with, the coat was certainly only punctate or tubercular; probably the structure was not mature, nevertheless the 'sporules' were distinctly evident.

These phenomena, exhibited by the Vine-fungus, clearly agree with those exhibited by the *Oidia* always accompanying certain ERYSIPHÆ, as described under that article; and therefore most of the authors who have written on this subject conclude that the Vine-fungus is really an *Erysiphe*, of which the perfect, ascophorous fruit has not yet been discovered. A comparison of figure 12. Pl. 20, from the Vine-, copied from Mohl, with those of the Hop-*Erysiphe*, fig. 14, will show the agreement of structure between the two plants.

It remains only to add a few remarks as to the interpretation or nomenclature of the different organs. Mohl, Tulasne, &c. have denominated the simple 'spores' above de-

scribed (figs. 8, 9) *conidia*; but as we have stated, the cells are convertible into what may be called *sporanges*, producing 'sporules' (or true spores) without alteration of structure. When their walls become cellular (fig. 12), the sporangial character is more decided; but as the *Erysiphæ* produce a more perfect *sporange*, in which *asci* are developed, the name of *pycnidia* is applied to them. This fruit it was which gave rise to the establishment of a supposed distinct genus, by Cesati, under the name of *Ampelomyces*; while Ehrenberg, also regarding it as a distinct plant, made it the type of a genus called *Cicinobolus*, on account of the peculiar tendril-like extrusion of the 'sporules' (fig. 12 *s*). Mohl distinguishes it as the *Cicinobolus*-fruit, which he, like Tulasne, finds constantly associated with other (undoubted) *Erysiphæ* (fig. 14), in very slightly different and equally irregular forms.

There can be no doubt whatever, in the minds of those who have watched the development and progress of the Vine-fungus, that it is the cause and not a consequence of the 'murrain;' still there are various curious circumstances connected with it not at all understood. It is probable that peculiar atmospheric conditions induce predisposing states of the plants; but the phenomena are enigmatical: we have had it completely covering a vine in a small greenhouse, destroying all the fruit one year; and although no precautions were taken (as it was desired to study the disease), no sign of mildew appeared there the next year; while on an out-door trellis, a few yards off, the disease reappeared in a slight form in the second season. The application of sulphur appears to arrest the growth.

BIBL. Berkeley, *Gardener's Chron.* 1847, no. 48, &c.; *Journ. Hort. Soc.* vi. p. 284, ix. p. 61; Montagne, *Bull. Soc. Centr. Agric.* 2 sér. v.; *Journ. Hort. Soc.* ix. p. 112; Amici, *Atti dell' Accad. de' Georgofili*, xxx. (transl. *Journ. Hort. Soc.* viii. p. 231; Savi, *ibid.* 241); Tulasne, *Bot. Zeit.* xi. p. 257 (1853); *Comptes Rendus*, xxxvii. (Oct. 1853).

VINEGAR, EELS IN. See ANGUILLULA.

VINEGAR-PLANT.—Under this name is known a remarkable vegetable production formed in fluids rich in sugar, when undergoing fermentation at ordinary temperatures and conversion into vinegar. As ordinarily met with, it forms a tough gelatinous mass floating on the surface of the liquid, its shape (superficially) defined by that of the vessel in which it is contained, extending itself so as to occupy the whole surface even in very large pans,—its depth or thickness depending on its age and the amount of nutriment contained in the liquid. The gelatinous substance decreases in density from above downwards, the lower part being very lax and flocculent, the inferior surface being in a state of continuous development. The general mass, however, displays remarkable tenacity, which, together with its lubricity, renders it difficult to tear; but if the lower surface is examined, it is found possible to strip off layer after layer, each a few lines thick, to an extent depending on conditions of growth, the lower, less dense portion being thus distinctly stratified.

When portions are placed beneath the microscope very varied forms of structure are discovered in the interior. The general mass of jelly appears structureless, as if formed by some exudation, or solution of the organized portion; but the mode of origin of this jelly is not yet ascertained. Imbedded in the jelly are cellular structures, polymorphous indeed, but exhibiting transitions which render it impossible to regard them as of distinct origin. In the middle portion often occur innumerable isolated masses of short rows of cells, resembling the cells of YEAST when coherent, except that they are generally elliptical; some of them have short cylindrical joints; others short cylindrical portions arising from long tubular filaments, and terminating in elliptical cells, so as to resemble exactly OIDIUM. The diameter of all these structures is most variable, from 1-4000 to 1-8000″. In the upper part, the elongated branched filaments more abound, the length of the internodes and the diameter of the tubes still varying extremely. At the lower, laxer surface, the cellular structures are accompanied by less of the tough gelatinous matrix. The lamination of the lower growing surface is very curious, but perhaps may be accounted for by supposing that the inferior growing surface of the mass, which is certainly the mycelium of a fungus, periodically produces a crop of *conidia*, which become detached and fall into the body of the liquid on which the mass floats; there quickly germinating, they form a new entangled mass of filaments and chaplets of cells, which then acquires its gelatinous consistence, and, buoyed up by the liquid, applies itself against the lower surface of the parent mass, with which it adheres, more or less,, on account of the gelatinous condition. In the upper part of old

and thick masses, the layers become inseparable—probably in some measure from the pressure of the floating force from below, together with the condensation arising from the evaporation of the liquid of the jelly at the upper surface.

When a vinegar-plant is left upon the solution after the saccharine matter is exhausted, we find it always display, after a certain time, patches of the ordinary fructification of PENICILLIUM *glaucum* (fig. 805), as stated by Turpin and others, forming green, blue, and yellow "mould" upon the surface, and imbedded in the upper strata, in which also heaps of the spores occur; the vinegar sometimes ultimately suffers more or less decomposition, so that the common "mother" of vinegar, which by its growth destroys the acidity, appears to be another condition of this same organism. In some cases where we kept an exhausted liquid in the dark for some months, the acidity of the vinegar disappeared, the gelatinous layer became greatly condensed, and assumed a bright crimson tint, and remained as a dull-red membranous film, somewhat like a smear of blood when dried upon paper.

Fig. 805.

Penicillium.
Head of a fertile filament bearing strings of spores.
Magnified 250 diameters.

From the above observations it would appear that the vinegar-plant consists of the mycelium of *Penicillium glaucum*, vegetating actively and increasing also by crops of *conidia* or gemmæ. This opinion is entertained by Turpin, Berkeley, and other observers; and the various genera and species founded on the different forms of structure occurring in it cannot be entertained: among these are *Ulvina*, Kütz., and species of *Hygrocrocis*, *Leptomitus*, &c. But the moniliform growth is at the same time scarcely distinguishable from the Yeast plant by any satisfactory characters; and repeated observations strongly impress us with the idea, that these objects are all referable to one species,—the vinegar-plant being the form of vegetative growth taking place at low or ordinary temperatures in highly saccharine liquids, while the true east plant or *Torula* is formed in the more rapid fermentation taking place at more elevated temperatures. Another circumstance, mentioned under PENICILLIUM, is that we have found stale beer-grounds, kept at a rather low temperature, always ultimately acquire a gelatinous crust, on which *Penicillium*-fruit becomes developed.

In connexion with this subject may be mentioned the objects called *Cryptoccoccus glutinis*, Fres., and the "blood on bread," which appear nearly related to the red-coloured condition of the vinegar-plant above mentioned. These are possibly merely forms of the same plant; indeed we have observed, on some flour paste partially covered with *Penicillium glaucum*, small circular patches of a crimson tint, which under the microscope were found to consist wholly of minute elliptical bodies, generally exhibiting two internal granules or "nuclei," and exactly resembling the articulations of some of the moniliform structures of the vinegar-plant, which readily separate into their component cells. All these phenomena require further investigation, to which long-continued and constant observation must be applied in order to ascertain with certainty the relation the different objects bear to each other. It is a kind of research occupying much time, and demanding great care and patience, but calculated to repay the trouble far better than the amassing of isolated characters of forms seen at different periods and under special conditions. Further particulars concerning various points treated in this article will be found under the heads FERMENTATION, OIDIUM, PENICILLIUM, TORULA, and YEAST.

BIBL. Turpin, *Mém. de l'Institut*, xvii. p. 135; Berkeley, *Journ. Hort. Soc.* iii. p. 91; Lindley's *Medic. & Econ. Bot.* p. 17; Fresenius, *Beitr. z. Mycol.* Heft ii. p. 77; Slack, *Mic. Trans.* 1865, p. 10.

VIRGULA'RIA.—A genus of Pennatulidæ (Alcyonaria). *V. mirabilis* is found in British seas, and has a long rod-like support to the short polype-bearing fringes.

VIRGULI'NA, D'Orb.—A subgenus of *Bulimina*, having outdrawn, very delicate, and smooth biserial shells, with extremely fine pores. The regular *Virgulinæ* are typified by *V. squamosa*, those of less regular growth by *V. Schreibersii*. The only variety taking on a sandy condition, becoming delicately rugose or subarenaceous, is *V. Hemprichii*, common in the Indian seas and in some Tertiary and Cretaceous strata, having

muddy dull shells of very variable growth, and presenting passages of form between *V. Schreibersii* and *Bulimina* proper. See Bolivina and Bulimina. Common, recent and fossil.

The extreme subcylindric modification of *Virgulina* is *Pleurostomella*, Reuss; the bi-uni-serial modification is *Bifarina*, P. & J.

Bibl. Ehrenberg, *Mikrogeologie*, passim; Parker & Jones, *Phil. Trans.* clv. 375; *Ann. N. H.* 4, ix. 284, 299.

VIS'CUM, Linn.—A genus of Loranthaceæ (Dicotyledons).

V. album is the mistletoe, alluded to under Embryo-sac, Liber, and Ovule.

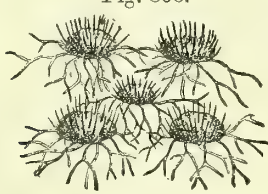
VITREOUS HUMOUR or body. See Eye.

VITTÆ of the valves of the Diatomaceæ.—These are internal projections or inflections of the valves, forming imperfect septa; they appear as dark lines, visible under ordinary illumination.

VITTÆ of fruits. See Secreting Organs of Plants.

VOLUTELLA, Fr.—A genus of Stilbacei (Hyphomycetous Fungi), comprising several species of parasites which have been variously distributed. The plants consist of minute fleshy papillæ (*stromata*) of cellular structure, the surface of which is clothed with elliptic, oblong, or fusiform stylospores, from between which project long jointed hairs (fig. 806) traversing the stroma.

Fig. 806.



Volutella buxi.
Magnified 20 diameters.

V. buxi, Berk. and Br. (*Fusisporium buxi*, Br. Fl., and *Chætostroma buxi*, Corda). White; on dry box leaves (fig. 806).

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 352–3; *Ann. Nat. Hist.* 2 ser. v. p. 466, pl. 11. fig. 3; Greville, *Crypt. Fl.* pls. 102 & 268. fig. 2; Corda, *Icon. Fung.* ii. pl. 13. fig. 107; Fries, *Syst. Myc.* iii. p. 447.

VOLVA'RIA, Fr.—A subgenus of *Agaricus* belonging to the rose-spored series, characterized by the presence of a universal volva and perfectly entire gills. One species is an object of cultivation in Italy, where old coffee-grounds are placed in a cellar, on which the fungus soon appears.

Bibl. Fr. *Syst. Myc.* i. p. 277; Berk. *Outl.* p. 139; Cooke, *Handb.* p. 83.

VOLVOCIN'EÆ.—A family of microscopic organisms which, in agreement with the majority of recent writers on Algology, we have included among the Confervoid Algæ, although they have been included until lately among the Infusorial animalcules, among which they form one of Ehrenberg's families. The most striking general character of these objects is their composition of individual elements which exhibit in their mature and most perfect stage of existence the characters of the transitory zoospores of the other Confervoids. The Volvocineæ may be characterized as plants composed of a number of permanently-active zoospore-like bodies associated together into families of definite form, in which the members, connected or held together in various ways by cell-membranes, retain their distinct individuality for all physiological purposes of nutrition, growth, reproduction, &c., but represent only one being in relation to the surrounding objects. *Protococcus*, however, consists of only a single cell. The best-known and most beautiful example of this family is the genus *Volvox* (Pl. 3. fig. 24), consisting when mature of a spherical membranous sac, at the periphery of which, within the membrane, are arranged a large number of zoospore-like bodies (*gonidia*), each provided with a pair of cilia, which pass out through the enveloping membrane, collectively forming a coating all over the external surface, and by their vibration causing a rotatory motion of the entire globe.

The modes of reproduction of the Volvocineæ, both vegetative and by spores, are fully described under Pandorina, Volvox, and Gonium; hence it is unnecessary to dwell on these points here.

It might be useful to observers to give the characters of all the above genera as laid down in Ehrenberg's work, in spite of our disbelief in their validity; but in so doing it would be necessary to describe them from his drawings, as his written characters are altogether useless, from being founded on false analogies. The red eye-spot is certainly found in *Gonium*, and probably in all; we doubt the statements about a *single* "proboscis" (vibratile cilium); and the so-called tail, a posterior prolongation of the body is an obscure character. The

tabular analysis which Ehrenberg gives would not enable any one to distinguish the forms without the assistance of plates. We have therefore prepared a table, founded on his characters and drawings, marking those genera which appear to us really distinct.

Char. Permanently active zoospore-like bodies, ciliated (except *Gyges*), surrounded by a gelatinous coat (like COCCOCHLORIS), solitary or combined in definite groups, with or without a common enveloping membrane. Individuals pyriform, or with the body prolonged posteriorly.

Solitary.
- Without cilia .... *Gyges.*
- With a pair of cilia .... { PROTOCOCCUS (*Chlamidomonas*).

Grouped.
- Forming a square layer, gonidia with two cilia .... } GONIUM.
- Forming a spherical body.
  - Cilium solitary.
    - With a "tail" .... *Uroglena*.*
    - Without a "tail."
      - Without an eye-spot.
        - With special coats ... *Syncrypta*.*
      - With an eye-spot.
        - Gonidia dividing into clusters .... } *Sphærosira*.*
  - Cilia two.
    - Without an eye-spot... *Synura*.*
    - With an eye-spet.
      - Common envelope spherical.
        - Gonidia numerous, all over the periphery ... } VOLVOX.
        - Gonidia eight, in a circle at the equator..... } STEPHANOSPHÆRA.
      - Common envelope ellipsoidal. Gonidia sixteen or thirty-two .... *Pandorina.*

* Probably stages of development of VOLVOX or PANDORINA.

The names in small capitals are well-established genera.

BIBL. See the genera.

VOLVOX, L.—A genus of Volvocineæ (Confervoid Algæ), of which only one species, *V. globator* (Pl. 3. fig. 24), seems satisfactorily established. This organism, occurring not uncommonly and often in great abundance in clear pools on open commons, &c., appears to the naked eye as a minute pale-green globule gently moving about in the water; its dimensious variable, but generally about 1-50″ when full-grown. When placed under a low magnifying power, it is found to be a spherical membranous sac, studded all over with green points, the entire body rolling over in the water with a motion which is readily discerned to be caused by innumerable cilia arranged upon the surface of the globe. In the interior of the sac are generally seen dense globes, in summer mostly of a green colour (Pl. 3. fig. 24): sometimes the cavity is wholly filled up by a number of membranous sacs exactly resembling the parent, but deformed by mutual pressure (Pl. 3. fig. 25); and inside these are seen smaller green bodies, as in the former case. The parent envelope is also flexible, yielding to pressure and recovering its form, and in full-grown specimens is generally ruptured at one point, where the internal bodies escape, so that the number varies; usually, however, the original number is eight.

The application of higher powers is requisite to discover the intimate structure of *Volvox*, which, by the researches of Williamson and Busk, most of whose observations we have verified, has been pretty clearly made out. The outer envelope consists of a layer of cell-membrane, in all probability composed of a modification of cellulose, although we have never succeeded in producing more than a faint purple tinge with sulphuric acid and iodine. By the application of a sufficient magnifying power, the green corpuscles at the periphery are found to consist of zoospore-like bodies (*gonidia*) (Pl. 3. fig. 28), which are seated inside the membranous envelope, each sending out its pair of vibratile cilia (figs. 24–30) through separate orifices in the external coat. The same investigation will reveal that the green gonidia have radiating processes extending from their sides, and running from the different centres to meet each other in the light interspace, forming thus a kind of delicate network beneath the membrane. The gonidia are pyriform, have a transparent anterior end bearing a pair of cilia, and contain a reddish-brown eye-spot and a contractile vacuole, thus exactly resembling those of *Gonium* and, indeed, the zoospores of Confervoids generally. The radiating processes resemble those found in particular stages of PROTOCOCCUS *pluvialis*, running through the gelatinous coat, and probably may be compared to the radiating filaments proceeding from the nucleus of SPIROGYRA (Pl. 5. fig. 26). There is somewhat more difficulty in determining the nature of the structure in which the gonidia are enclosed. There is a layer of soft consistence of some thickness within the external membrane; the green gonidia are wholly imbedded in this; and their radiating processes and cilia traverse the substance of it. We are inclined to believe that this presents a firm membranous layer again at the internal

surface, looking toward the general cavity of the sphere. The nature of the soft layer has been the subject of discussion; we believe Busk's view to be correct, that it is not formed by the collocation of distinct membranous cells, like those of ordinary parenchymatous structures, but by the close juxtaposition of gelatinous envelopes of the individual green bodies, resembling those of *Coccochloris, Glœocapsa*, &c. We could never detect a true line of demarcation halfway between neighbouring gonidia: an appearance is indeed sometimes presented in preparations kept in chloride of calcium, which might lead to an error on this point; for the outer membrane is then sometimes swollen into papillæ opposite each corpuscle (Pl. 3. fig. 30), the furrows between which in certain foci give the appearance of a septum running round each corpuscle (Pl. 3. fig. 29). Similar preparations also often show the gonidium contracted and leaving an empty ring round it, separating it from the gelatinous coat, which runs undistinguishably into those of the neighbouring gonidia. But the strongest fact we have observed is that by the application of solution of potash the substance surrounding the gonidia is so entirely dissolved that the oily substance extracted from the green bodies will run freely about beneath the external membrane (apparently confined internally by another film), in sheets extending over considerable segments of the sphere, yet leaving the gonidia and their radiating processes intact, or at least only shrunk and discoloured. If a true cell-membrane existed around each gonidium, forming septa dividing them, the above phenomenon could not display itself, since the potash would not so dissolve the structures.

The modes of reproduction of *Volvox* have recently been entirely elucidated. In certain conditions, some of the gonidia appear larger than the rest, and as if undergoing division (Pl. 3. fig. 27); it is possible that some of the gonidia, or of such grouped gonidia, escape into the cavity, and there become developed into the large green bodies (Pl. 3. fig. 24), which are rudimentary globes; but Williamson believes these are detached in an earlier stage: perhaps both modes of development take place. Forms with the grouped gonidia (Pl. 3. fig. 29) would appear to represent Ehrenberg's *Sphærosira*. Ehrenberg's genus *Uroglena*, again, would seem to be a *Volvox* either imperfectly developed or decaying.

The deep-green bodies (Pl. 3. fig. 24) seen in the cavity of the spheres, are young *Volvoces*, and in an early stage they appear as spherical cells filled with granular green substance; the green substance divides by segmentation (Pl. 3. figs. 31, 32) until it forms a group of gonidia, on each of which a pair of cilia appears; the enclosing membrane expands, and they follow it and remove apart, until they form a perfect *Volvox*-sphere, studded with the gonidia. As above mentioned, a second generation is sometimes met with in the parent sphere (Pl. 3. fig. 25). We are uncertain whether to regard the objects represented in Pl. 3. fig. 14, as the young of *Volvox*; they would seemingly equally represent the genus *Pandorina, Syncrypta*, or *Eudorina*, Ehr.

Volvox, examined in autumn and early winter, often exhibits either the green bodies with a thick coat (Pl. 3. fig. 33), or the inner globes are of an orange colour (Pl. 3. figs. 26 & 34), which appear to be successive stages of development of a *resting-spore*. When mature, this possesses at least two coats, one immediately surrounding the granular contents, another at some distance outside the former, transparent, colourless, and as it were glassy and brittle, breaking with sharp-angled cracks when pressed (Pl. 3. figs. 34 & 35). We cannot detect any intermediate substance or layer, which would be required to complete the analogy with the resting-spore of Spirogyra as described by Pringsheim (Pl. 5. fig. 21); perhaps it does not exist in either case. Sometimes the outer coat of the enclosed yellow globes is tuberculated or covered with conical elevations (Pl. 3. fig. 36). The form with the smooth yellow resting-spores (Pl. 3. figs. 26 & 34) represents Ehrenberg's *Volvox aureus*, and the form with the spines (Pl. 3. fig. 36) his *V. stellatus*. The development of the resting-spores of *Volvox* has been fully described by Cohn, and presents an essential resemblance to the process in Pandorina and Stephanosphæra. A portion of the gonidia become enclosed in special cyst-like coats; and their contents are then converted into spermatozoids, which break out and move actively in the interior of the spherical common envelope. These bodies fertilize other gonidia, which take on the function of spore-cells; and after their impregnation the latter acquire the firm coats and yellow contents characteristic of the resting-spores. They are set free at first into the common cavity of the spherical envelope.

A doubt remains as to the nature of the object described as *Synura uvella*; it may belong here, or, not improbably, to the genus *Uvella* (Pl. 25. fig. 18), which itself may be no more than a complex form of the PROTOCOCCUS or *Chlamidomonas* (Pl. 3. fig. 2; Pl. 23. fig. 30), which doubtless includes also *Chlorogonium* (Pl. 23. fig. 31), *Cryptoglena* (Pl. 23. fig. 35), and *Gyges* (Pl. 41. fig. 14), if not more supposed Infusorial animalcules.

When a pool contains *Volvox*, the individuals are generally abundant, and may be readily seen by the naked eye, as pale-green globules, in a phial of water held up to the light; but they are kept with difficulty, being devoured by ROTATORIA, &c. The cilia are best seen by drying them and wetting again, or by applying iodine. The gonidia are a good deal altered by chloride of calcium.

BIBL. Ehr. *Infus.*; Pritchard, *Infus.*; Williamson, *Trans. Phil. Soc. Manchester*, vol. ix.; *Trans. Micr. Soc.* 2 ser. i. p. 45 (1853); Busk, *ibid.* p. 31; Cohn, *Ann. des Sc. Nat.* 4 sér. v. p. 323; *Ann. Nat. Hist.* 2 ser. xix. p. 187; Rabenh. *Fl. Eur. Alg.* iii. p. 26.

VORTICEL'LA, Linn.—A genus of Infusoria Ciliata, of the family Vorticellina.

Char. Body campanulate, with an anterior ring of cilia, stalked; stalk simple, spirally contractile.

These interesting Infusoria are very commonly met with in decomposing vegetable infusions, as of hay, portions of dead flowers, &c. See INFUSORIA.

Ehrenberg describes many species; but their diagnosis and true characters have still to be worked out.

1. *V. nebulifera* (Pl. 25. fig. 21). Body conico-campanulate, colourless; anterior margin dilated; body without rings when contracted. Length of body without the stalk 1-576 to 1-288″.

2. *V. microstoma* (Pl. 25. fig. 26, body with gemmæ). Body ovate, narrowed at the ends, greenish white; anterior margin not dilated, nor body ringed when contracted. Length of body 1-2000 to 1-250″.

3. *V. convallaria.* Body ovato-conical, whitish hyaline, annulate; expanded anterior margin slightly prominent. Length of body 1-430 to 1-240″.

Dujardin unites the genera *Carchesium* and *Zoothamnium* to his genus *Vorticella*.

BIBL. Ehr. *Infus.* p. 269; Duj. *Infus.* p. 546; Lachmann, *Ann. Nat. Hist.* 1857, xix.; Clap. et Lach. *Etudes*; Greefe, *Ann. Nat. Hist.* 1872, pp. 105, 196, 384, 462; Allman, *Qu. Mic. Jn.* 1872, p. 393.

VORTICELLI'NA.—A family of Infusoria Ciliata. See p. 410 for distinctive characters.

Table of Genera.

						Genus.
VORTICELLINA.	Without a posterior crown of cilia during the greater part of their life.	Vorticellina naked.	A peduncle.	Peduncle contractile.	Not branched	1. *Vorticella.*
					Branched. Each branch having a special muscle..	2. *Carchesium.*
					Branched. A single muscle which ramifies ...	3. *Zoothamnium.*
				Peduncle not contractile		4. *Epistylis.*
			No peduncle.	Posterior part of body with a bourrelet or else a circular sphincter		5. *Scyphidia.*
				No bourrelet or sphincter		6. *Gerda.*
		Vorticellina sheathed.	No true sheath, and the peduncle is lost in a gelatinous mass			7. *Ophridium.*
			A sheath.	Animal fixed to the base of the sheath.	Sheath fixed by its bottom	8. *Cothurnia.*
					Sheath fixed on its side ...	9. *Vaginicola.*
				Animal suspended freely in the sheath		10. *Lagenophrys.*
	With a posterior ciliary crown during the whole of their life, and the animal is free					11. *Trichodina.*

BIBL. Claparède et Lachmann, *Etudes*, p. 93; Allman, *On development of*, *Qu. Mic. Jn.* 1872, p. 393.

VORTICLA'VA, Alder.—A genus of Hydroida.

Char. Polypites borne on simple stems, developed at intervals on a creeping filiform stolon, the whole cœnosarc clothed with a very delicate film-like polypary; tentacles in two dissimilar verticils, the oral short and capitate, the aboral long and filiform. Reproduction unknown.

BIBL. Hincks, *Brit. Hydr. Zooph.* p. 131; T. S. Wright, *Qu. Mic. Jn.* iii. n. s. p. 50.

VULVULI'NA, D'Orb.—See TEXTULARIA.

W.

WART.—The common hard wart consists of a circular group of elongated papillæ with their free extremities slightly enlarged and bulbous, their vessels dilated and extending close up to the epithelial covering.

This presents its normal threefold division, inasmuch as a thick layer of transition-cells fills up all the interstices between the enlarged papillæ, while the horny lamina invests the group of papillæ with a common covering.

BIBL. Rindfleisch, *Path. Hist.* i.

WASP. See VESPA.

WATER.—Under this head we might form a kind of index referring to a large proportion of the articles of which this volume is composed, since water, existing under different circumstances, forms one of the most fertile sources of microscopic objects; but as our space and plan do not admit of such an enumeration, we must be content to dwell shortly upon two of the most important questions in which the microscope is applied to the examination of the contents of water.

Ordinary examination of water.—Here it appears merely necessary to point out that the mode of examining the contents of samples of water, for the purpose of ascertaining the extent to which organic beings are contained in them, should be very different from that pursued by the microscopist who is engaged in collecting specimens. We make this remark in consequence of the gross misrepresentations which are sometimes made respecting the "animalcules" in water, carried to their most absurd extreme in the so-called "drop" of water shown by oxyhydrogen microscopes, where we often see the field covered with larvæ of dragon-flies, of beetles, of gnats, &c., Entomostraca, and worms of different kinds, not only perceptible without a microscope, but in the case of the larvæ, perhaps really more than an inch long. Less violent exaggerations occur when water which appears cloudy is selected, allowed to stand for some time, and the *sediment* examined. Very false results must also be obtained when water is exposed to the air for any length of time before examination, since Infusoria and microscopic Algæ always appear in a short time, even in distilled water, when exposed to the atmosphere; and a rain-water butt will generally be found a very fertile source of microscopic objects. We regard the presence of most of those organisms which do not sufficiently affect the water to render its impurity discernible by the naked eye, as a matter of little consequence. Large quantities of Entomostraca, certain Rotatoria and Infusoria, and Oscillatoriaceous Algæ, generally very perceptibly clouding or colouring the water, of course indicate the presence of much decomposing organic matter in the water, which, however, reveals itself very clearly in a short time, when the water is kept, by a fœtid odour. The presence of green Confervoid Algæ is by no means a sure sign of impurity (properly so called) in water; for some will only grow in very clear and pure water, while many of them may be regarded as agents of purification. The presence of Zygnemaceæ, however, and Diatomaceæ is particularly objectionable, as they become very fœtid in decomposition, which generally takes place very soon when they are disturbed and injured. When large quantities of the minute Algæ appear in water, discolouring it over extensive surfaces, the microscope will enable us to detect the nature of the object producing the appearance, but will scarcely be requisite to prove the impurity of the water.

Coloration of water.—Under this head we shall refer to those plants and animals which most commonly produce such appearances, premising that the commonest cases of coloration depend upon suspended mineral substances (mud), of different colours according to the soils washed by the water.

1. Producing a general *green* colour, or a thick film on the surface.—PROTOCOCCUS (*Chlamidomonas*, Ehr., *Diselmis*, Duj.), very common in the spring; and various Nostochaceous Algæ, as TRICHORMUS, CONIOPHYTUM, &c. (see NOSTOCHACEÆ; many with a bluish tinge); CLATHROCYSTIS (forming a granular verdigris-green layer), MICROHALOA, and various other PALMELLACEÆ; EUGLENA *viridis*, &c. The DESMIDIACEÆ form greenish patches at the bottom of water or on plants, as do certain OSCILLATORIACEÆ.

2. Producing a *red* colour in fresh water.—ASTASIA *hæmatodes* Ehr.; species of DAPHNIA. TUBIFEX produces a red colour on the mud in shallow water. Red forms of species of PROTOCOCCUS (see also RED SNOW).—In salt water, DISELMIS *Dunalii*, Duj.; TRICHODESMIUM.

3. A brown cloudy appearance often appears in masses near the source of small springs of water flowing out of blue clay, or in pools on peat-bogs. This mostly consists of peroxide of iron; but sometimes a similar brown appearance is produced in pools by collections of amorphous granular decaying organic matter, in which occur great abundance of certain OSCILLATORIÆ,

Diatomaceæ, Infusoria, and Rotatoria. The obscure mycelioid structure called by Kützing Leptothrix *ochracea* produces a yellowish-brown tint. Diatomaceæ often form a yellowish-brown coat on mud at the bottom of water. Many Rotatoria and larger Infusoria (Paramecia, &c.), when abundant, give water a slightly milky appearance.

The above list is undoubtedly very imperfect, but may afford some useful hints. Microscopists who meet with such colorations will naturally examine them carefully; they will find further information under the heads of the articles cited.

WATER-BEARS. See Tardigrada.

WAXY KIDNEY is produced by amyloid infiltration of the uriniferous tubes and by a similar alteration of the vessels; and the application of iodine proves that most of the tissues are impregnated with amyloid matter.

Bibl. Rindfleisch, *Path. Hist.* ii.

WEBBI'NA, D'Orb. (Restricted.)—A subgenus of *Trochammina*; adherent, single-celled, moniliform, or alternating. Recent and fossil.

Bibl. Parker and Jones, *Phil. Trans.* clv. 435; P., J., and Brady, *Monog. Crag For.* 25.

WEISSIA, Hedwig.—A genus of Pottiaceous Mosses.

WHALEBONE.—In whales the teeth are rudimentary; and arising from a depression in the upper jaw on each side are a number of parallel horny plates, many feet in length, which project downwards: these plates, which are technically known as fins or blades, constitute whalebone; and through them the water containing the animals upon which the whale lives is strained, and the food thus obtained. These plates are situated upon a vascular membrane, folds of which enter a cavity at their base, which is the portion connected with the jaw.

Whalebone may be pretty easily divided into longitudinal laminæ and fibres; but these are only secondary forms resulting from the aggregation of a number of cells, of which whalebone wholly consists.

On examining a transverse section of a blade or plate of whalebone with the naked eye, or a lens, two structures are readily distinguishable—an inner porous-looking medullary portion, surrounded by an outer compact or cortical substance. A longitudinal section through the plate exhibits a number of dark lines or stripes, from about 1-100 to 1-150″ in diameter, parallel to each other and to the axis of the plate, and corresponding to the pores seen in the transverse section. These stripes, which have been called whalebone-canals, but which we shall denominate medullary lines, are seen to be surrounded by a paler substance.

With a higher power ($\frac{1}{2}$ inch), the transverse section exhibits in the centre a number of rounded apertures or circles corresponding to the pores (Pl. 17. fig. 31), surrounded by very fine, concentric, interrupted dark lines, whilst towards the circumference these lines run parallel to the surface of the plate. In the longitudinal section, viewed with this power, the medullary lines are seen to consist of a number of cells (Pl. 17. fig. 30), mostly arranged in single longitudinal series, and, in dried whalebone, having a very dark appearance by transmitted light, from the presence within them of a large quantity of pigment and air. These are the medullary cells. The substance between the lines of medullary cells exhibits very fine longitudinal striæ, and, in parts, the ends of divided laminæ.

On macerating whalebone for twenty-four hours in solution of caustic potash, it becomes soft; and on afterwards digesting it in water, the cortical portion resolves itself into numerous large transparent cells, from 1-230 to 1-310″ in length, and from 1-500 to 1-330″ in breadth (Pl. 17. fig. 33). These contain a variable number of granules of pigment, of a deep brown colour, also some small globules of fat, which are especially numerous in those portions nearest the base of the plate. These cells in the natural whalebone are laterally compressed or flattened; and the transverse axes of those surrounding the medullary lines are arranged tangentially to the latter, whilst in the cortical portions these axes are parallel to the surface of the plate. The concentric lines seen in a transverse section arise principally from the pigment-granules within those cells which surround the medullary cells becoming arranged in a linear series by the flattening of the cells enclosing them. This may be shown by treating a transverse section of whalebone with caustic potash, and then adding water and watching its resolution into cells. As these expand, the interrupted lines are seen also to expand as it were, and to become resolved into a number of distinct pigment-granules existing within each cell. The lines seen in a longitudinal section arise from the unequal refraction of light by the

laminæ of compressed cells surrounding the medullary lines.

The medullary cells contain a large quantity of pigment, as do also those compressed cells which immediately surround them; in the former these granules are frequently aggregated. In the common dry whalebone of commerce the medullary cells also contain air, which has been mistaken for fat, and hence the cells denominated fat-cells. The air is readily displaced by liquids. Between the compressed cells minute cavities containing air, sometimes assuming a linear form, at others representing mere dots, are seen both in the transverse and longitudinal sections; these are distinguished by the displacement of their contents. Hence ordinary whalebone closely resembles hair or horn in its structure; and the fibres which are seen projecting from the margin of the blades as found in commerce have a remarkable similarity to hair (Pl. 17. fig. 32). Chemically, it consists of a proteine compound, and is therefore coloured by Millon's and Pettenkofer's test-liquids.

Whalebone polarizes light like horn.

BIBL. Donders, *Mulder's Physiol. Chemie*; Lehmann, *Phys. Chem.*; Hunter, *Phil. Trans.* 1787.

WHEAT.—The STARCH of the grain of wheat (*Triticum vulgare* and other species and varieties) presents itself in the form of delicate little flattish lenticular bodies, very characteristic (Pl. 37. fig. 8). Wheat is subject to various BLIGHTS, which are referred to under that head, depending on the growth of parasitic Fungi, especially TILLETIA, attacking the ear, PUCCINIA attacking the straw, &c. In other cases the ear is found infested with a minute worm (ANGUILLULA *tritici*) remarkable for its tenacity of life.

WINGS OF INSECTS.—The arrangement of the veins or nerves of the anterior wings of the Hymenoptera is sometimes used to form the basis of systematic arrangement; and the several veins and interspaces have received distinct names, which may be illustrated by reference to Pl. 27. fig. 11, representing the anterior wing of the humble-bee (*Bombus terrestris*): *a*, costal nerve; *b*, cubital nerve; *c*, posterior margin of wing, with the fold (*n*) for the attachment of the hooks; *d*, postcostal nerve; *e*, externo-median; *f*, anal; the nerve between 3 and 10, the transverso-median; *h*, the radial nerve; *k*, the discoidal; *l*, the subdiscoidal; *m, m, m*, transverso-cubita nerves; *s*, stigma; 1, costal cell; 2, median cell; 3, interno-median; 4, anal; 5, marginal; 10, first discoidal cell; 11, second ditto; 12, third ditto; 13, first apical cell.

See INSECTS, *wings*.

BIBL. That of INSECTS; Jurine, *Nouvelle Méthode*, &c.; Shuckard, *Trans. Entom. Soc.* i.; Staveley, Miss, *Neuration &c. of Wings, Linn. Trans.* xxiii. 125; Semper, *Siebold & Kölliker's Zeitschr.* viii. 326.

WINTERE'Æ.—A section of the Dicotyledonous family Magnoliaceæ (DRIMYS, *Tasmannia*), remarkable for the character of the elementary structure of the wood, approaching closely to that of the Coniferæ. It consists, as in that family, wholly of pitted prosenchymatous cells without ducts, the cells having two or three rows of bordered pits, as in ARAUCARIA. A distinction exists, however, in the character of the medullary rays, which are very numerous in Wintereæ, occurring both large and small, six or seven in the breadth of 1-12″ in a vertical section at right angles to the rays—some of them being thin, composed of one or two parallel layers of cells, extending to a vertical extent of about ten cells, others much larger, ten or twelve cells thick (or broad), and of a vertical extent of eighty or a hundred cells; the latter are very evident on the surface of the wood when the bark is removed. The medullary rays here traverse all the annual layers of wood, which is not the case in the Coniferæ.

BIBL. Goeppert, *Linnæa*, xvi. p. 135 (1842); *Ann. des Sc. Nat.* 2 sér. xviii. p. 317.

WOOD.—The mode of origin of wood is explained in the articles CAMBIUM, MEDULLA, MEDULLARY RAYS, and VASCULAR BUNDLES, while the characters of the elementary organs of which wood is composed are described under the heads of CELL; FIBROUS, PITTED, and SPIRAL STRUCTURES; and SECONDARY DEPOSITS. Peculiar composition of the wood in certain classes, families, or genera of plants is also noticed under their especial heads, which will be referred to presently. In this article the principal kinds of modification of the wood (taken as a whole) occurring in these said cases, and in certain others, are to some extent classified, in order to indicate their relations, and to furnish a guide to microscopists seeking to observe the most remarkable varieties of structure occurring in this substance.

The elements entering into the composition of wood are :—1. FIBRO-VASCULAR BUNDLES, which in their most complete form contain SPIRAL and other VESSELS, PITTED DUCTS, PROSENCHYMATOUS cellular tissue with thickened walls (*woody fibre*); and in the Monocotyledons, *vasa propria*, as they are called by Mohl, viz. elongated tubular cells of membranous structure occurring in the centre of the bundles. 2. MEDULLARY RAYS in the Dicotyledons, or a generally diffused medullary parenchyma in the Monocotyledons. 3. Woody PARENCHYMA, which is found under different conditions and in different quantities in different cases.

The GYMNOSPERMS may be considered in the above enumeration as agreeing with the Dicotyledons. The less-generally diffused structures connected with Secretion are here left out of view.

In classifying the kinds of wood, we may commence with the less perfect forms.

Monocotyledons.—In our native plants of this class the stem is mostly herbaceous, and the woody structure then occurs simply in the form of "fibres" (*fibro-vascular bundles*) (fig. 456, p. 487), the structure of which has been described elsewhere (fig. 791, p. 814). The same kinds of elements are arranged in nearly the same way in most of the arborescent plants of this class, such as Palms—for example, in the Cocoa-nut Palm, in the common Cane (*Calamus*), or the various striped solid canes (all Palms) used for walking-sticks, &c. The solid woody texture depends in these upon the interspace between the fibro-vascular bundles being filled up with *woody parenchyma, i. e.* the general medullary substance, which in such stems as that of the White Lily is soft and spongy, in the Palms &c. becomes solidified by the great deposition of secondary layers upon the walls of the cells; thus the bundles, at first "fibres," are bound together into a solid *wood.* The thick woody walls of the hollow Bamboo cane are constructed on the same plan, being highly developed and lignified forms of the structure which is exhibited in a soft and herbaceous condition in our common Grasses.

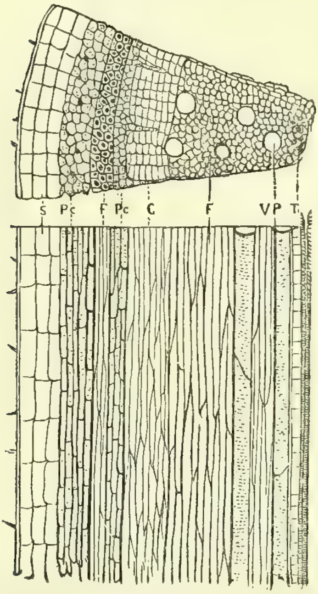
Certain Monocotyledons present a structure which differs from the above in the appearance presented by transverse sections. In the Smilaceæ, and some of the Dioscoreaceæ, the fibro-vascular bundles are arranged in more definite order in one or two circles; but there is no distinction of pith, medullary rays, and bark here; the bundles are bound together by *woody parenchyma*, and there is no cambium-region beneath the rind. The anomalous growth exhibited by the stems of other Monocotyledons, such as *Dracæna*, *Yucca*, &c., cannot be regarded as depending on the formation of *wood* in the proper sense; in them, layers of fibrous structure are formed between the central region of the stem (containing the original vascular bundles) and the rind, which take their origin from the ends of the vascular bundles at the periphery of the stem beneath the rind, and extend down in a kind of false cambium layer beneath the rind.

Interesting objects illustrating the above structures are furnished by longitudinal and transverse sections of the trunks of large Palms and of the large woody leaf-stalks of these, of canes of different kinds, of Bamboo canes, the rhizome of Sarsaparilla plants (*Smilax*), *Ruscus*, the harder parts of the stem often found attached to imported Pine-apples, &c. Sections of silicified fossil Palm-stems, prepared by the lapidary, can also be obtained from the dealers in objects.

Dicotyledons.—In this class we meet with a remarkable diversity in the character of the wood, which moreover here exhibits, from the indefinite power of growth of the FIBRO-VASCULAR BUNDLES, a much more extensive and perfect development than in the Monocotyledons. In the articles MEDULLA (fig. 455, p. 487), MEDULLARY RAYS (fig. 457, p. 488), and VASCULAR BUNDLES (fig. 792, p. 815) are described the conditions of ordinary Dicotyledonous stems in the first year of their growth; it is stated in the account of the vascular bundles, that a new layer of wood is developed in the cambium layer in each succeeding season (fig. 457, p. 488). The nature of the elementary structures in such cases is illustrated by the accompanying figures from the Maple (*Acer campestre*) (figs. 807 & 808), of which the former represents sections of a shoot at the beginning of its second year, when the cambium layer (c) is swelling, the latter a shoot of three years' growth, the portions belonging to each year being indicated by the figures. The only difference between the structure developed in each succeeding season is the absence of a layer of spiral vessels (*medullary sheath,* in the first year) at the point where each year's

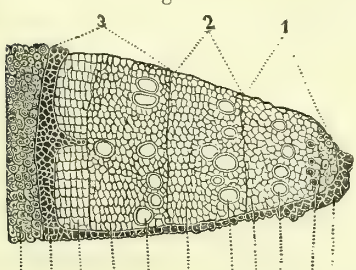
growth commences. Here, as is seen, the body of the wood is composed chiefly of

Fig. 807.



Transverse and vertical section of a segment of a shoot of the Maple in the early part of the second year of its age. T, spiral-vessels; VP, pitted ducts; F, woody fibre; C, cambium; Pc, cortical parenchyma; F, liber fibres; Pc. cellular envelope of the bark; S, corky layer of ditto. Magnified 60 diameters.

Fig. 808.



Transverse section of Maple-wood three years old. The figures 1, 2, 3 indicate the annual rings of wood; the rest is bark. *m*, medulla; *t*, spiral vessels; *v*, ducts; *f*, woody fibre; *c*, cambium; *me*, medullary parenchyma; *l*, liber. Magnified 40 diameters.

prosenchymatous cells (wood-cells or woody fibre) (*f*), with a few pitted ducts (*v*) near the commencement of each annual layer; the medullary rays are narrow in this wood. In the Hornbeam (*Carpinus Betulus*) the wood is of very similar composition; the wood-cells, however, are more thickened, and the ducts exhibit a spiral marking; the annual layers are not very clearly defined in sections under the microscope. This is the case, again, with the excessively hard wood of the *Box* (*Buxus sempervirens*), which is of analogous composition. The Birch (*Betula alba*) has the same structure. Other common timber-trees exhibit an additional structure in their wood, namely masses of *woody parenchyma* interspersd in various ways among the ordinary prosenchymatous structure of the wood. A very small quantity of this occurs in scattered groups in the common oak (*Quercus pedunculata*); here also the ducts are very large, appearing as open holes to the naked eye in cross sections; the larger medullary rays are likewise very evident. In the beech (*Fagus sylvatica*) there is a small quantity of woody parenchyma, but greatly thickened prosenchyma prevails; the ducts are rather small; but the broader medullary rays are very evident, appearing to the naked eye as brown streaks in longitudinal sections. The Chestnut (*Castanea vesca*) differs from this chiefly in wanting the broader medullary rays. In the Elm (*Ulmus campestris*) the prosenchyma is interposed between bands of woody parenchyma and wide ducts, which renders the distinction of the annual layers obscure. The Walnut-tree has no woody parenchyma; the Apple- and Pear-trees have alternate bands of prosenchyma and woody parenchyma; these exist, but are narrower in the Plum and Cherry. In the wood of most of the Leguminosæ (*Robinia, Ulex, Genista, Gleditschia*, &c.) the woody parenchyma appears in bands of considerable size; but the walls of its cells are less thickened than those of the prosenchymatous cells. Woody parenchyma occurs extensively in Mahogany and Rose-wood, producing a peculiar variation of colour in the wood; the large holes are the orifices of the very wide ducts.

The wood of the Poplars (*Populus*) and Willows (*Salix*) has the prosenchymatous cells little thickened. The Hazel (*Corylus Avellana*) and the Alder (*Alnus glutinosa*) present a peculiarity: the wood appears to the naked eye to have broad medullary rays; but under the microscope these rays are found to be portions of the wood devoid of ducts, intervening between segments with

closely-pitted ducts placed at particular points in the annual rings. The Lime (*Tilia*) and the Horse-chestnut (*Æsculus*) have wood of soft texture, the prosenchymatous cells being only slightly thickened; while the ducts are large and numerous (these exhibit a spiral band, very evident in the Lime). The wood of the Plane (*Platanus occidentalis*) has strongly marked medullary rays; the prosenchymatous cells are greatly thickened; and mingled with them are very numerous ducts, and a small quantity of woody parenchyma. The stem of the Vine (*Vitis vinifera*) has likewise long and broad medullary rays; the wood is composed of prosenchymatous cells, with a spiral-fibrous deposit on their walls, while the cells of the woody parenchyma are devoid of this; the ducts are very long, and exhibit every gradation of form, from spiral, reticulated, and scalariform to pitted ducts. The various species of *Clematis* have strongly marked medullary rays, and wood chiefly composed of pitted ducts, as is the case also in the common Rose.

In many of the above trees the wood acquires a special peculiarity when it attains a certain age; the prosenchymatous cells generally become more solid, year by year, through the filling-up of their cavities by the increasing thickness of the secondary deposits on their walls: in the lighter-coloured and softer woods, such as the Lime, there is no distinct line of demarcation between the older and younger part of the trunk—the *alburnum* or *sap-wood* and the *duramen* or *heart-wood*; but in many cases, as in the Ebony (*Diospyros*), Lignum vitæ (*Guaiacum*), to a less extent in the Elm, Oak, &c., the *duramen* assumes a remarkable solidity and a deeper colour, so that after a certain time the colours of the *duramen* and *alburnum* are very different. This appears to arise from a chemical alteration of the substance of the secondary deposits of the prosenchymatous cells.

A great degree of regularity and agreement of structure exists between the woods of the Dicotyledons above mentioned. It remains to direct attention to various kinds which depart more or less from the type thus selected.

In the various parasitical Dicotyledons, such as *Lathræa, Melampyrum, Cuscuta,* &c., there is no layer of spiral vessels corresponding with the medullary sheath; and in the Mistletoe (*Viscum*) only annular ducts occur in this situation; the wood in the latter is largely composed of woody parenchyma, the cells of which are punctated, or possess spiral-fibrous layers (figs. 665, 666, page 723). The stem of *Myzodendron* also exhibits some remarkable anomalies.

In the Bombaceæ (*Bombax, Carolinea,* &c.) the mass of structure corresponding to the wood is chiefly composed of membranous parenchymatous cells, with scattered isolated prosenchymatous cells, and large pitted ducts. The wood of *Avicennia* is principally composed of large pitted ducts, with narrow interspaces filled up with small pitted parenchymatous cells.

The wood of the Cactaceæ (*Mammillaria, Melocactus*) is composed of dotted ducts, together with a kind of cell, apparently referable to parenchyma, the walls of which have a remarkably broad spiral-fibrous band (Pl. 39. fig. 7). The wood of the *Casuarinæ* exhibits a curious structure: it is composed of long prosenchymatous cells, the walls of which, together with those of the numerous large ducts, have bordered pits (Pl. 39. fig. 2); while concentric lines of cellular tissue appear at intervals in the cross section, consisting of plates of parenchyma extending from one medullary ray to the next, and connecting them. The stems of some of the Menispermaceæ have likewise concentric processes of parenchymatous tissue. In the WINTEREÆ, a section of the Magnoliaceæ, the wood is wholly composed (with the exception of the medullary sheath) of pitted prosenchymatous cells resembling those of *Araucaria* (Pl. 39. fig. 5), without any ducts.

In certain families of Dicotyledons a remarkable appearance arises from the arrangement of the bundles in several circles, almost as in the Monocotyledons; but this results in a very different kind of structure, on account of the unlimited growth of the cambium in Dicotyledons. Examples of this kind of wood occur in the Chenopodiaceæ, Nyctaginaceæ, Piperaceæ, &c. In *Pisonia*, which has been supposed to grow in the same way, the result is a solid mass of wood, composed of prosenchymatous cells and ducts, with isolated perpendicular cords of parenchyma (exactly the reverse of what occurs in the Monocotyledonous stems). The woods of *Phytocrene* and *Nepenthes* may be further cited as offering remarkable peculiarities.

It would exceed the space which we can allow to this article to enter into a description of the anomalous Dicotyledonous stems

of the tropical *lianes*, or climbing trees, of the families *Bignoniaceæ*, *Menispermaceæ*, *Malpighiaceæ*, &c., the irregularities of the wood of which depend upon deviations from the normal type arising in the course of the growth of the stems, which, from the observations of Treviranus, Crüger, and others, appear to be mostly regular when quite young. Isolation of one or more fibro-vascular bundles from the central cylinder of wood, producing distinct centres of development, is the most common cause of irregularity.

The wood of Dicotyledons must be examined by transverse sections and perpendicular sections parallel with and at right angles to the medullary rays. The same applies to the wood of Gymnosperms. The mode of cutting these sections is stated elsewhere.

Sections of recent woods are best preserved wet in chloride of calcium. Fossil wood, if silicified, is cut (in similar directions) by the lapidary's wheel; wood in the state of coal in like manner, or in the way stated under COAL (see PREPARATION, FOSSIL WOOD, and COAL).

Gymnosperms.—In this division of the Flowering Plants we also meet with two types of structure:

Coniferæ.—Here the character of the wood agrees in general with that of the typical Dicotyledons, with certain distinctions; namely, although the medullary sheath of spiral vessels exists, no ducts or vessels occur in the mass of wood external to this, which is wholly composed of prosenchymatous cells, with bordered pits, in single (Pl. 39. fig. 4) (usually), double, or treble (*Araucaria*) rows (Pl. 39. fig. 5); in *Taxus* accompanied in part by a spiral-fibrous band (Pl. 39. fig. 4). The particulars of these forms are given under CONIFERÆ. It may be mentioned that the "woody parenchyma" of Dicotyledons seems to be represented here by the cords of parenchymatous cells in some cases traversing the prosenchyma, ultimately filled with resinous deposits ("cords of secretion-cells").

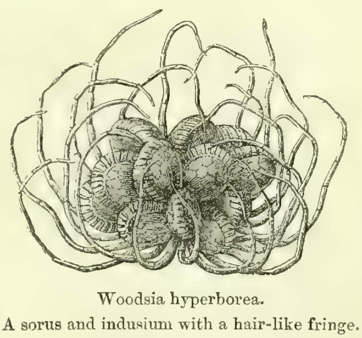
Cycadaceæ.—The earliest condition of the stems here appears to resemble that in Coniferæ; but no annular rings are formed. Concentric layers are produced at intervals, however, separated by parenchymatous layers. The true mode of origin of these does not appear to be clearly made out. The wood is composed of pitted prosenchymatous cells (Pl. 39. fig. 20), without vessels or ducts, excepting in the medullary sheath of spiral vessels.

For further details on the markings of the ducts, &c., see PITTED and SPIRAL STRUCTURES.

BIBL. Lindley, *Intr. to Bot.*; DeCandolle, *Organographie*, i. p. 161; Meyen, *Pflanzenphys.* i. p. 331; Schleiden, *Grundz.* 3rd ed. i. p. 253 (*Principles*, p. 56), *Wiegmann's Archiv*, 1830, i. p. 220, *Beitr. z. Bot.* p. 29, *Mém. Acad. St. Pétersb.* 6 sér. iv. (1842); Goeppert, *De Struct. Conifer.* Vratislav. 1841, *Linnæa*, xvi. p. 747, xvii. p. 135, *Ann. des Sc. Nat.* 2 sér. xviii. pp. 1 & 317; Brongn. *Végét. Fossiles*, Paris, 1828, *et seq.*, *Ann. des Sc. Nat.* 1 sér. xvi. p. 589; Hooker, J. D., *Flor. Antarct.*, *Ann. des Sc. Nat.* 3 sér. v. 193; Gaudichaud, *Recherches Anatom.*, *&c.* Paris, and *Ann. des Sc. Nat.* 3 sér. passim; Meneghini, *Ricerche sulla Struttura Monoc.*; Schacht, *Pflanzenzelle*, p. 193, *Das Baum*, p. 94; Crüger, *Botan. Zeit.* viii. p. 99, x. p. 465; Trécul, *Ann. des Sc. Nat.* 3 sér. xviii. xix., xx., 4 sér. i., ii., iii.; Milde, *Beitr. z. Bot.* Heidelb. 1850; Hanstein, Pringsheim's *Jahrb. f. wiss. Bot.* i. p. 232; Sanio, *Linnæa*, 1858; Hartig, *Bot. Zeitung*, xvii.

WOOD'SIA, R. Brown.—A genus of Cyathæous Ferns, represented by two rare indigenous species. The indusia are of an open

Fig. 809.



Woodsia hyperborea.
A sorus and indusium with a hair-like fringe.
Magnified 50 diameters.

cup-shape, and bear long hairs on the margin (fig. 809).

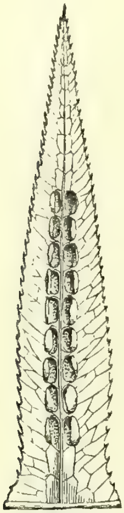
WOODWAR'DIA, Smith.—A genus of Asplenieæ (Polypodioid Ferns). Exotic. (fig. 810, p. 838).

WOOL OF ANIMALS. See HAIR (p. 358). The fibres of wool are coloured by the test-liquids of Millon and Schultze.

WRANGE'LIA, Ag.—A genus of Cera-

miaceæ (Florideous Algæ), differing from *Griffithsia* chiefly in the scattered tetraspores.

Fig. 810.



Woodwardia.
A fertile pinnule. Magnified 5 diameters.

W. multifida, the only British species, has rose-red feathery fronds, an inch high, consisting of a main filament, about as thick as a bristle, composed of a single row of cells, bearing long, pinnately-arranged, patent branches, mostly branching in the same way again. At the articulations occur two opposite (or more rarely a whorl of) pinnato-multifid or subdichotomous ramelli 1-12 to 1-6″ long. The fructification consists of: —1. *favellæ*, borne on stalks at the joints, and surrounded by a whorl of ramelli; and 2. elliptical *tetraspores*, opposite, secund or tufted, on the lower part of the ramelli. In some foreign species *antheridia* have been observed in similar situations to the tetraspores.

Bibl. Harvey, *Brit. Mar. Alg.* p. 169, pl. 24 D; *Phyc. Brit.* pl. 27; Derbès and Solier, *Ann. des Sc. Nat.* 3 sér. xiv. p. 273, pl. 35; Thuret, *ibid.* 4 sér. iii. p. 38.

X.

XANTHID'IA.—The bodies found in flint, and thus called, are probably sporangia of Desmidiaceæ (Pl. 19. figs. 22–28). They have been distributed in genera and species, the description of the characters of which would be useless.

XANTHID'IUM, Ehr.—A genus of Desmidiaceæ.

Char. Cells single, constricted in the middle; segments compressed, entire, spinous, with a circular, usually tuberculated projection near the centre. Spines more than two to each segment.

X. armatum (Pl. 10. fig. 23; fig. 24, empty cell, showing the projections). Segments broadest at the base; spines short, stout, tri- or multi-fid. Length 1-180″.

X. fasciculatum (Pl. 10. fig. 25). Segments with from four to six pairs of subulate marginal spines; central projections minute, conical, and not beaded. Common. Length 1-400″.

Sixteen species.

Bibl. Ralfs, *Brit. Desmid.* p. 111; Rabenht. *Fl. Eur. Alg.* iii. 221; Archer *in Pritchard's Infus.*

XANTHIOPYX'IS, Ehr.—A genus of fossil Diatomaceæ, consolidated with Pyxidicula. It consisted of those species the margins of the valves of which are furnished with a dentate membrane, or the surface covered with setæ or hair-like processes. From Bermuda.

Bibl. Ehr. *Ber. d. Berl. Akad.* 1844. p. 264; Kütz. *Sp. Alg.* p. 23; Pritchard, *Infus.* p. 826.

XENOD'OCHUS, Schlecht.—A genus of Uredinei (Coniomycetous Fungi), consisting of black tufts, found on the leaves of *Poterium*, containing microscopic, short, curved, usually shortly stipitate filaments, attenuated at each end, composed of a moniliform row of (five to fifteen) globose cells filled with black granules.

These bodies occur associated with *Uredo miniata*, of which *X. carbonarius* appears to be the perfect form. *Xenodochus* is only distinguished from Phragmidium by the greater number of joints.

Bibl. Schlechtendahl, *Linnæa*, i. p. 237; pl. 3. fig. 3; Fries, *Summa Veg.* p. 505; Berkeley, *Ann. Nat. Hist.* i. p. 263.

XENOSPHÆ'RIA, Trevis.—A genus of Micro-lichens, parasitic in the thallus of *Solorina saccata*.

Char. Spores 6–8, oblong, 4–6-locular, brown; sometimes large, irregular, and muriform.

Bibl. Körber, *Syst.* p. 326; Lindsay, *Qu. Mic. Jn.* 1869, p. 344.

XESTOLEB'ERIS, G. O. Sars.—One of the *Cytheridæ*, with subtriangular valves, higher behind than in front, smooth, with distant papillæ; lower antennæ with 4

joints; upper 6-jointed, with simple setæ, and short. Two living British species, common.

Bibl. Brady, *Tr. Lin. Soc.* xxvi. 437.

XIPHICHI'LUS, Brady.—One of the *Cytheridæ*, near *Paradoxostoma*; with subequal, compressed valves, elongate, pointed, thin, and smooth. Two living British species, rare.

Bibl. G. S. Brady, *Nat. Hist. Tr. North. & Durh.* iii. 369.

XYLA'RIA, Schrank.—A genus of Sphæriacei (Ascomycetous Fungi), several of which are common on rotten wood, stumps of trees, &c. They are branched, horny or fleshy bodies, with often clavate lobes, whitish and mealy when young, afterwards brown or black, with black, horny, immersed perithecia all over the branches, or with the tips barren; the perithecia have a black centre composed of asci, each containing eight (usually uniseptate) spores.

Bibl. Berk. *Brit. Flor.* ii. pt. 2. p. 234 (Nos. 8 to 11); Fries, *Summa Veget.* p. 381.

XYLOG'RAPHA, Fr. pr. p., Nyl.—A genus of Graphidei, Lichenacei.

Char. Apothecia black, linear, parallel, plane, internally cinerascent; spores 8, simple. 1 sp., rare.

Bibl. Leighton, *Brit. Lich. Flora,* p. 362.

Y.

YEAST(-plant). — This well-known substance, which possesses the remarkable property of resolving sugar in solution into alcohol and carbonic acid, consists of a minute fungus, or rather of a particular condition of development of a certain fungus.

When yeast from an actively fermenting liquid is examined with the microscope, it is seen to consist of myriads of minute cells or vesicles, of about 1-3000 to 1-2400″ (Pl. 20. fig. 23) in diameter, containing a nucleus and some granules. During the progress of the fermentation, these cells increase in number, by budding, until either the sugar or the nitrogenous matter of the fermenting liquid is exhausted, when the cells, especially those nearest the surface, become elongated, remaining connected end to end, until they reach the surface, where they produce their fructification.

The growth of the yeast-plant has been carefully studied by several observers. We may describe some observations of our own, which confirm those of Mitscherlich and others. Some fresh wort, in which fermentation had commenced, was obtained from a brewery, and a drop of the liquid, containing yeast-globules, placed upon a slide and covered with a piece of thin glass. After the removal of the extraneous liquid, the upper glass plate was cemented to the lower one; the slide was then placed under the microscope, with the 1-4th object-glass and the micrometer eyepiece, in such a manner that several well-formed globules were visible; and these were drawn on ruled paper.

At first the globules or cells enlarged until they had attained a certain size; then there elapsed a short interval, during which no change was observable. Next there took place a projection of some point of the cell-wall, which first appeared as a little point-like bud, afterwards becoming larger and larger, until at last a new cell, of the size of the parent cell, was formed. Within three hours a cell was so far developed that a new one was formed from it, and thus an independent individual perfectly developed. The rapidity of growth probably varies with the temperature and the nature of the process: in twenty-four hours, when the thermometer was at about 78° in the day, sixteen cells were developed from one; after a time the growth slackened; finally no further increase took place, undoubtedly because all was removed from the liquid which could serve for their growth. Growing globules from this experiment are figured in Pl. 20. fig. 23.

Messrs. Berkeley and Hoffman went a step further, by contriving to get an atmosphere of air round the drop of sugar and water, and saw the cells of the yeast-fungus as soon as it reached the air, developed into a *Penicillium.*

By the observations of numerous competent investigators, it seems certain that the fermentation of beer, of wine, and in fact all vinous fermentation, is effected by the growth of this plant; and after the evidence brought forward in the articles Fermentation, Torula, and Vinegar-plant, there is little doubt that the Vinegar-plant, the *Oidium lactis,* and other supposed distinct plants are but forms of the Yeast-plant. Fig. 24 (Pl. 20) exhibits the condition of the Yeast-plant on the surface of exhausted wort of malt, before the Vinegar-fungus appears; fig. 756, page 788, the *Torula*-form at the margins of the surface of liquids.

We cannot clearly make out any difference between the 'top-yeast' and 'bottom-yeast' (*Oberhefe* and *Unterhefe* of the Germans), beyond the difference resulting from more

or less active development; when the growth is rapid the cells are more spherical and become quickly detached, and the evolution of gas comes up more to the surface. When the yeast vegetates quietly at the bottom of the liquid, its cells are more elongated. We do not believe the yeast-cells ever burst to discharge reproductive granules. The globular form is known by various names, as *Mycoderma cerevisiæ*, Desm., which agrees with *Cryptococcus glutinis*, Kütz.; the globular form in the Vinegar-plant is Kützing's *Ulvina aceti*; the filamentous form with simple moniliform fruit (fig. 756) is *Torula cerevisiæ*, Turpin; without fruit, species of *Hygrocrocis* or *Leptomitus*, the final form being apparently *Penicillium glaucum*.

The Yeast-plant is truly most ubiquitous; but so are the conditions for its growth, while its reproductive power is enormous, and its small size renders it liable to be scattered by imperceptible movements of the air. *Aspergillus glaucus* is almost as constant in its favourite nidus, cheese; *Mucor mucedo* on paste, &c.; *Botrytis vulgaris* on dead leaves and stems in damp places, &c.: and all these are certainly not pseudomorphic productions; and if, as we believe really to be the case, yeast is but the *conidial* form of *Penicillium glaucum*, there has been no lack of the spores of the latter in the air, in any situation where we have ever exposed vegetable substances for any length of time to a damp atmosphere.

The Yeast-fungus is often developed in ripe grapes, causing vinous fermentation. In an article lately published in Ann. d. Sc. Nat. the globules are regarded by Karsten as merely pathological; but this is contradicted by the facts above mentioned.

Bibl. Turpin, *Mém. de l'Institut*, xvii. p. 93 (1840); Lowe, *Trans. Edinb. Bot. Society*, 1857; Bail, *Flora*, 1857, p. 417; Berkeley, *Crypt. Botany*, pp. 242, 299; Schleiden, *Grundzüge der Botanik*, 3rd ed. i. p. 235 (*Principles*, p. 32); and the *Bibl.* of Fermentation; Karsten, *Ann. Nat. Hist.* s. 4. xiii. p. 161.

YEW. See Taxus.

Z.

ZA'MIA, Lindl. See Cycadaceæ.

ZAN'CLEA, Gegenbaur.—A genus of Corynidæ, Hydroida.

Char. Stem simple or branched, rooted by a creeping filiform stolon, the whole invested by a chitinous polypary; polypites more or less clavate. Tentacles capitate, scattered over the body; gonophores borne on the body of the polypite and originating free medusiform zooids. Umbrella nearly spherical (at liberation); manubrium not reaching the margin of the bell, with a simple mouth; radiating canals four; marginal tentacles two, set along one side with pedunculated sacs filled with thread cells.

Bibl. Hincks, *Brit. Hyd. Zooph.* p. 58; Gegenbaur, *Versuch eines Syst. d. Medusen, in Zeit. f. wiss. Zool.* 1856, 229.

ZE'TES, Koch.—A genus of Arachnida, of the order Acarina and family Oribatea. It is consolidated with *Galumna*.

ZINC.—The crystals of the *lactate*, as deposited from an aqueous solution, are represented in Pl. 7. fig. 20; they belong to the right-rhombic prismatic system.

The *chloride of zinc* is a useful as a preservative of animal tissues. (See Preservation.)

Chloriodide of zinc. See Schulze's Test.

Bibl. That of Chemistry.

ZOËA.—In the first or larval stage of the metamorphosis of some Crustacea the animal is thus termed; for instance, the edible crab.

ZONARIA, Harvey (*Aglaozonia*, Zanard, Kütz.).—A genus of Dictyotaceæ (Fucoid Algæ), of which the British species, *Z. parvula*, forms olive-green, membranous, fan-shaped fronds, 1″ or more in diameter, growing over stones or corallines, to which it attaches itself by whitish fibres on the lower surface. It is scarcely marked with concentric lines like Padina. The fructification occurs in scattered sori on both surfaces, and is apparently analogous to that of Padina, but requires further examination, since Thuret has shown that the true Dictyotaceæ have peculiar reproductive organs, spores, tetraspores, and antheridia, so that they stand between the Fucaceæ and the Florideæ.

Bibl. Harvey, *Brit. Mar. Alg.* p. 38, pl. 6 D; Thuret, *Ann. des Sc. Nat.* 4 sér. iii. p. 25.

ZONOTRIC'HIA, J. Ag. = Ainactis and Euactis.

Bibl. Rabenht. *Fl. Eur. Alg.* i. 212.

ZOOGLŒA, Cohn. See Bacterium.

ZOOID—.A term applied to marine and freshwater animals which do not as yet resemble the parent form; such, for instance, as the ciliated ovoid mass which escapes from the ova of Actinozoa. This at last

fixes itself on to some hard substance, loses its cilia to a great extent, and develops into the perfect form.

ZO'OPHYTES.—These are the Cœlenterata, and do not properly include the Polyzoa. The zoophytes, or plant-like animals, are therefore the Hydrozoa and the Actinozoa. The first of these groups has been mentioned especially in reference to HYDRA, which may be taken as its type; and the second may be noticed in the form of the sea-anemone. The general anatomy of the Actiniæ may be gleaned from most standard works on comparative anatomy. The histological elements which are sufficiently known are those of the ectothelium, the endothelium, the muscular layers, the chromatophores or coloured bodies outside the tentacles and the nerves; but there is still a great field for research in the structure of the visceral cavities and the tube-like appendages to them and the so-called mesenterium. The ectothelium or outside skin consists of nematocysts or thread-cells placed side by side, of large refractive cells of intercellular granular colouring-matter, and of a deep layer of cells. Cilia are rather scarcer than is usually imagined. The endothelium consists of nematocysts placed side by side amidst vast numbers of ciliated cells on a base of small cells, most of which are nucleated. No striped fibres exist; but there are two very distinct kinds of muscular fibre. One kind is broad and ribbon-shaped, with long nuclei; and the fibres of the other are thread-like with oval nuclei. The connective tissue abounds; and its fibres are refractive and not granular.

The cells of connective tissue approach the multipolar in shape now and then; but their size and the refractive nature of the processes distinguish them from true nervous structures. Masses of connective tissue with irregular meshes give support and origin to the muscular structures, especially of the base, of Actiniæ; and they are replaced in other positions by delicate layers of tissue which resembles in its wavy fibres the ordinary white fibrous tissue of Vertebrata. The chromatophores, or coloured bodies, at the outer base of the tentacles in some genera, are composed of an outer layer of small rods or bacilli, which rest on large refractive, spherical, or ovoid cells; and these cover the points of a series of long cylindrical conical-ended cells filled with refractive fluid. Granular colouring-matter intervenes between these histological elements and becomes continuous at the bases of the last-mentioned long cells with a nucleated cell-tissue, in which are multipolar cells, nerve-tubes, and a nervous plexus. At the base and in amongst the muscular layers is a diffused nervous system; but in the tentacles only multipolar cells exist close to the inner cavity, which is lined with cilia. The long mesenteric cordons are profusely ciliated externally, and when separated may be mistaken for individual organisms. See Plate 33. figs. 1–6, 7 & 8.

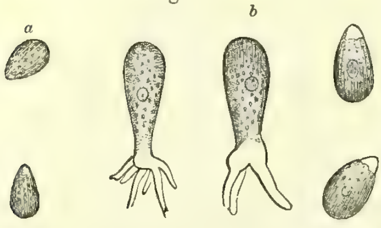
BIBL. Homard, *Ann. des Sci. Nat.* 1851; Grant, *Zool. Trans.* i. p. 10; Huxley, *Elem. Comp. Anat.*; Greene, *Manual of Cœlenterata*, 1861; Edwards & Haime, *Hist. Nat. des Corall.*; Schneider & Rötteken, *Sitzungsber. d. Oberhess. Gesells. für Nat. u. Heilk.* 1871; *Ann. Nat. Hist.* 1871, p. 437; Lacaze-Duthiers, *Ann. des Sci. Nat.* passim; Duncan, *Brit. Foss. Corals, Pal. Soc. Intro.*; *Nerv. Syst. of Actinia, Proc. Roy. Soc.* No. 151, 1874, p. 263.

ZO'OSPORES.—The name given to the ciliated active gemmæ or GONIDIA produced either singly or, more frequently, after segmentation, in numbers, out of the contents of ordinary or special cells of the Algæ, without any previous process of fertilization. These bodies are generally discharged from the parent cell in the state of PRIMORDIAL UTRICLES, and acquire a cellulose coat subsequently, when they cease to move, and settle down to germinate and produce a structure resembling the parent. In some cases (in HYDRODICTYON normally, in many other Confervoids abnormally) they become encysted within the parent cell; and it appears most probable that the small cysts with dense (and often spinulose) coats, such as occur in *Spirogyra* (Pl. 5. figs. 24, 25) and other genera under certain circumstances, are of similar origin. In the VOLVOCINEÆ, zoospore-like bodies form the permanently active individuals of the families.

True zoospores occur pretty generally throughout the Confervoid Algæ (with the exception of Oscillatoriaceæ, Nostochaceæ, and perhaps Diatomaceæ), and are described under the heads of the families or genera. A brief review may be permitted here. The largest form is that produced in the apices of the filaments of VAUCHERIA (fig. 796); it is ciliated all over, and very unlike that of any other genus. In *Œdogonium* (Pl. 5. fig. 7 *c*, & fig. 811) the zoospores are formed out of the whole contents of a cell, and have a crown of cilia around the transparent

'beak.' In other Confervaceæ, as *Cladophora* (Pl. 5. figs. 13 *c*, *d*), *Conferva* (Pl. 5, figs. 10 *b*, 11 *c*); in Chætophoraceæ, as in *Chætophora* (Pl. 5. fig. 9), *Draparnaldia* (fig. 180, page 259), *Stigeoclonium* (Pl. 5. fig. 5 *c c*); in Ulvaceæ, *Ulva* (Pl. 5. figs. 2 *b*, 3 *c*, *d*), *Enteromorpha* (Pl. 5. fig. 4 *b*); in *Protococcus* (Pl. 3. fig. 2 *b*), in ACHLYA, in

Fig. 811.



Zoospores of Œdogonium. *a* have lost their cilia; and in *b* germination is more or less advanced. Magnified 200 diameters.

Desmidiaceæ (Pl. 6. fig. 11), &c., as in all other cases, they are formed either singly from the entire contents, or in small or large number by the segmentation of the entire contents, and mostly break out in various ways, as pyriform bodies with two or four cilia on the transparent beak, moving actively for a time, and then germinating to produce new plants. They appear usually to be surrounded at the moment of discharge by a delicate common sac, composed of cellulose, which expands and quickly disappears, apparently by solution, setting them free; in PEDIASTRIUM, however, this envelope appears to be permanent and to hold the gonidia together in the characteristic group or family (Pl. 6. fig. 11). In HYDRODICTYON, as described under that article, their history is different, though the earlier conditions are analogous. It has been found that zoospores of two very different sizes are produced in many Confervoids: these are called *macrogonidia* and *microgonidia* by A. Braun (see HYDRODICTYON); and a different function is supposed to be exercised by the latter by some authors, who believe they are fertilizing bodies (like SPERMATOZOIDS).

Zoospores exist in a large proportion of the Algæ usually included under the FUCOIDEÆ, but which Thuret separates under the name of Phæosporæ, including all the families except the FUCACEÆ, DICTYOTACEÆ and Tilopterideæ, which are (for the present?) distinguished by possessing antheridia and spores proper. The Phæosporous families bear organs called SPORANGES (usually described in Algological works as "spores"), from which are discharged *zoospores*, agreeing in all essential respects with those of the Confervoids, except that the two cilia are often arranged fore and aft, instead of being both in front. Examples of these are described under ECTOCARPUS, MYRIONEMA, CUTLERIA, LAMINARIA, &c. Zoospores have been discovered in Fungi (*Peronospora*) by De Bary, and in Lichens by Famitzin; and if *Saprolegniæ* are really aquatic Fungi, their existence is then notorious. See SAPROLEGNIA.

It remains to direct attention to the distinction between ZOOSPORES and SPERMATOZOIDS, which are sometimes confused together. This confusion is rendered more imminent by the manner in which the *forms* pass one into another. The essential character of a *zoospore* is, that when separated from the parent it becomes encysted and at once developed into a new individual resembling the parent. An exception to this occurs in some of the zoospores of ŒDOGONIUM, which, as the *androspores*, produce special structures in which are developed spermatozoids.

Spermatozoids are transitory structures; when discharged from the parent cell, they either make their way to a germ-cell of a spore, fertilize it and disappear, or, if debarred from this, at once perish without germination. As stated under SPERMATOZOIDS, these bodies vary much in form. In the higher Cryptogamia they are spiral filaments (Pl. 32. figs. 31–4). In the Fucaceæ they are minute globular bodies with two cilia (fore and aft) closely resembling some zoospores; in the Florideæ they appear to be globules without cilia; and those recently described as existing in VAUCHERIA, among the Confervoids, are also biciliated globules with the cilia fore and aft, while those in SPHÆROPLEÆ resemble the *microgonidia* of this family, having their pair of cilia on the beak; in ŒDOGONIUM they resemble the zoospores, but are smaller. The latter observation is in favour of the microgonidia of *Hydrodictyon*, &c. being spermatozoids.

ZOOTEIʹRA, Wright.—A genus of Actinophryina (Rhizopoda).

Char. Body furnished with numerous contractile acuminate rays, elevated on a contractile pedicle. Rays become thickened towards the point when not fully expanded.

BIBL. S. Wright *in Pritchard's Infusoria*, p. 563.

ZOOTHAM'NIUM, amended by Claparède and Lachmann.—A genus of Vorticellina (Infusoria Ciliata).

Char. Peduncle-muscles ramify in all the branches of the group. See synopsis of VORTICELLINA.

Ehrenberg describes two species; Stein adds two more. Claparède and Lachmann notice and figure four species.

Z. arbuscula (Pl. 25. fig. 22). Branches of polypidom racemose-umbellate, bodies white, stalks very thick. Aquatic; length of polypidom 1-4″; of bodies, 1-430″.

BIBL. Ehr. *Infus.* p. 288; Stein, *Infus.* passim; Clap. et Lach. *Etudes,* 101.

ZOS'TERA, L.—A genus of Monocotyledonous Flowering Plants (Nat. Ord. Zosteraceæ), growing in sea-water; remarkable for the POLLEN, of which the grains are represented by tubular filaments destitute of an outer coat and exhibiting ROTATION when fresh.

ZYGNE'MA, Agardh, in part (*Tyndaridea,* Bory, Hassall).—A genus of Zygnemaceæ (Confervoid Algæ), consisting of filamentous plants, with the green contents of the cells arranged in twin stellate or lobed masses in each joint (fig. 137, page 196). This stellate appearance arises from the presence of radiating threads, like those from the nucleus of SPIROGYRA; hence it cannot be well observed in dried specimens. Cell-division with previous division of the stellate masses may be well studied in this genus. Kützing separates from this genus all the forms in which the spore is formed in the cross branch produced in conjugation, associating them with *Zygogonium.* We prefer to follow Hassall's distribution of the forms, seeing that *Zygogonium ericetorum* is a plant of very different appearance. If the said character is constant, this genus might be divided into two.

Spores in one of the parent cells.

1. *Z. cruciata* (fig. 137, p. 196). Filaments 1-600″ in diameter; joints equal or twice as long; spores globose (Hassall, *l. c. infra,* pl. 38. fig. 1; Kütz. *l. c. infra,* v. pl. 17. fig. 4). *Z. Dillwynii* and *stellina* of Kützing appear to be only smaller states of this, as also *Tynd. lutescens,* Hassall, and *T. anomala,* Ralfs.

2. *Z. stagnalis.* Filaments 1-2640″ in diameter, joints three or four times as long; spores globose or oblong (Hassall, *l. c.* pl. 38. figs. 9, 10). *Tynd. ovalis,* Hass., is perhaps a larger form of this.

3. *Z. insignis.* Filaments 1-1800 to 1-1560″ in diameter, joints twice as long; spores globose (Hass. *l. c.* pl. 38. figs. 6, 7; Kütz. *l. c.* v. pl. 17. fig. 1).

4. *Z. bicornis.* Filaments 1-440 to 1-200″ in diameter, joints twice as long; spores globose (Hass. *l. c.* pl. 38. fig. 5; Kütz. *l. c.* v. pl. 16. fig. 3).

Spores in the cross branches.

5. *Z. immersa.* Filaments 1-1200″ in diameter, joints about half as long again; transverse processes very thick, filled by the large and globose spore (Hass. *l. c.* pl. 39. fig. 3; Kütz. *l. c.* v. pl. 12. fig. 5).

6. *Z. conspicua.* Filaments 1-1440 to 1-1080″ in diameter, joints equal or twice as long; transverse processes long, ventricose in the middle, where they enclose the ovate-globose spore (Hass. *l. c.* pl. 39. figs. 1, 2; Kütz. *l. c.* v. pl. 12. fig. 2).

7. *Z. decussata.* Filaments 1-1440″ in diameter, joints three times (more rarely five times) as long; transverse processes short and filled by the globose spore (Hass. *l. c.* pl. 39. fig. 6; Kütz. *l. c.* v. pl. 11. fig. 4).

8. *Z. Ralfsii.* Filaments 1-1920 to 1-1440″ in diameter, joints three or four times as long; transverse processes very much dilated in the middle, containing an elliptical spore, with the long axis at right angles (Hass. *l. c.* pl. 39. figs. 4, 5; Kütz. *l. c.* v. pl. 11. fig. 2).

9. *Z. pectinata.* Filaments 1-660″ in diameter, joints equal or a little shorter; cell-contents transversely bipartite, more frequently radiato-dentate, pectinate, dull green (Kütz. *l. c.* v. pl. 14. fig. 4; *Eng. Bot.* pl. 1611?). Possibly this is only a state of *Z. cruciata* with the spores in the transverse processes; if so, the subdivision above indicated cannot stand.

Probably other species exist in Britain; but we cannot satisfactorily ascertain them.

BIBL. Hassall, *Brit. Flor. Algæ,* p. 160, pls. 38, 39 (*Tyndaridea*); Kütz. (*Zygnema* and *Zygogonium,* in part), *Tab. Phyc.* v. pls. 11–17, *Sp. Alg.* pp. 444, 445; Rabenh. *Fl. Eur. Alg.* iii. p. 248.

ZYGNEMA'CEÆ (Pl. 5. figs. 16–28).—A family of Confervoid Algæ, consisting of plants composed of articulated cylindrical filaments, the cells of which often have the green contents arranged in elegant patterns. The principal mode of reproduction, whence the family takes its name, is by CONJUGATION, followed by a mixture of the entire contents of the united cells, and their con-

version into a spore. Other phenomena occur in some instances, such as the production of ciliated zoospores, and small spore-like bodies with a dense spinulose coat (*asteridia*); but these appearances are not yet thoroughly understood (see SPIROGYRA and MOUGEOTIA).

The British Genera are:—

1. *Spirogyra.* Filaments simple, with the green contents arranged in one or more spiral bands upon the cell-wall. Conjugation normally by transverse tubular processes; spores formed in one of the parent cells (or occasionally in both).

2. *Zygnema.* Filaments simple, with the green contents arranged in two globular or stellate masses in each cell. Conjugation by transverse processes; spores formed in one of the parent cells, or in the cross branch.

3. *Zygogonium.* Filaments simple, or slightly branched, with the contents diffused or arranged in two transverse bands. Conjugation by transverse processes; spores globose, formed in the cross branches, or in blind lateral pouches without conjugation.

4. *Mesocarpus.* Filaments simple, with the contents diffused. Conjugation by transverse processes, from which the filaments become recurved; spores in the dilated cross branches.

5. *Staurocarpus.* Filaments simple, with the contents diffused (or rarely in moniliform lines). Conjugation by transverse processes, from which the filaments become recurved; spores (or sporanges) square or cruciate, in the dilated cross branches.

6. *Mougeotia.* Filaments simple, soon bent at intervals, contents mostly diffused, sometimes in several serpentine lines. Conjugation by the inosculation of the filaments at the convexity of the angles; spores not satisfactorily known.

Thwaitesia, Montagne, resembles *Zygnema* in its stellate cell-contents; but the spore (?) formed in one of the parent cells divides into four portions (perhaps not distinct from *Zygnema*).

A. Braun has described two new genera, viz. *Craterospermum*, nearly resembling *Staurocarpus* and *Mougeotia*, but with the spore and the short tube in which it is contained subconstricted in the middle.

Pleurocarpus. Simple filaments, with diffused contents, the conjugation taking place between adjacent cells of the same filaments, by means of a short arcuate tube; spore globose, in the tube.

Rhynchonema, Kützing, has spiral cell-contents like *Spirogyra*, but conjugates like *Pleurocarpus*, by an arched tube connecting adjacent cells of the same tube.

BIBL. Kützing, *Spec. Alg.*, *Tabul. Phyc.*; A. Braun, *Alg. Unicell.* p. 60; Rabenh. *Fl. Eur. Alg.* iii. p. 110.

See also the genera.

ZYGOC'EROS, Ehr.—A genus of Diatomaceæ. Detached frustules of BIDDULPHIA?

BIBL. Ehrenberg, *Abhandl. d. Berl. Akad.* 1839, p. 131; Kützing, *Bacill.* p. 138, and *Sp. Alg.* p. 139; Rabenh. *Fl. Eur. Alg.* i. p. 30.

ZYGODAC'TYLA, Brandt.—A genus of Campanulinidæ (Hydroida).

Char. Hydrothecæ with an operculum formed by many convergent and acuminate segments; polypites cylindrical, with the tentacles webbed below. Reproduction by free medusiform zooids. Gonozooid: umbrella more or less hemispherical; manubrium short, with many fimbriated lips; radiating canals very numerous; marginal tentacles very numerous, with bulbous bases; lithocysts borne on the margin of the umbrella.

Z. vibrina, Ilfracombe.

BIBL. Hincks, *Brit. Zooph.* p. 191.

ZYGODES'MUS, Corda.—A genus of Sepedoniei (Hyphomycetous Fungi). *Z. fuscus* occurs upon bark of fallen branches. Mr. Berkeley thinks it possibly may be a form of some Thelephoroid Fungus. Mr. Currey has shown that Corda's figure (fig. 812) is

Fig. 812.

Zygodesmus fuscus.
Magnified 400 diameters.

not completely accurate, since he finds the points at the apex of the fertile pedicels each crowned by a spore; and the normal number of sterigmata is probably four, so that the structure would resemble a basidium of Hymenomycetes. The above figure is after Corda.

BIBL. Berk. *Crypt. Bot.* p. 298; Currey, *Micr. Journ.* v. p. 126.

ZYG'ODON, Hook. and Taylor.—A genus of Orthotrichaceous Mosses, deriving its

name from the yoking of the teeth in pairs; the species are mostly found in mountainous districts and rarely in fruit.

ZYGOGO'NIUM, Kütz. — A genus of Zygnemaceæ (Confervoid Algæ), consisting of filamentous plants, growing on damp ground or in water, green or yellowish when fresh, purple or brownish when dry. Kützing includes here all Hassall's species of *Tyndaridea* (Zygnema) which produce the spore in the cross branch.

Z. ericetorum, Kütz. Filaments 1-2160 to 1-1440″ in diameter, joints as long or half as long again; cylindrical or torulose (filaments sometimes slightly branched). Conjugation rare, apparently mostly 'chain-like,' from one cell to the next in the same filament. Contents green when growing in water, purple when growing on wet heaths (Hass. pl. 41; Greville, *Sc. Crypt. Fl.* pl. 261. fig. 1). *Conferva ericetorum*, Dillw.

See Zygnema.

Bibl. Hassall, *l. c.*; Greville, *l. c.*; Kützing, *Sp. Alg.* p. 445, *Tab. Phyc.* v. pl. 10, &c.; *Eng. Bot.* pl. 1553; Rabenh. *Fl. Eur. Alg.* iii. p. 251.

ZYGOSEL'MIS, Duj.—A genus of Infusoria, of the family Euglenia.

Char. Form variable; movement effected by two similar flagelliform filaments, incessantly in action.

Z. nebulosa (Pl. 25. fig. 23). Body colourless, sometimes globular, at others variously expanded so as to become pyriform or top-shaped, turbid from the presence of numerous granules. Aquatic; length 1-1100″.

Bibl. Dujardin, *Infus.* p. 369; Pritchard, *Infus.* p. 545.

ZY'GOSPORE.—The result of the union of conjugating Algæ.

THE END.

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THE

MICROGRAPHIC DICTIONARY;

A GUIDE TO THE EXAMINATION AND INVESTIGATION

OF THE

STRUCTURE AND NATURE

OF

MICROSCOPIC OBJECTS.

BY

J. W. GRIFFITH, M.D. &c.,

MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS;

AND

ARTHUR HENFREY, F.R.S., F.L.S., &c.,

PROFESSOR OF BOTANY IN KING'S COLLEGE, LONDON.

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J. W. GRIFFITH, M.D. &c.,

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ASSISTED BY

THE REV. M. J. BERKELEY, M.A., F.L.S.,

AND

T. RUPERT JONES, F.R.S., F.G.S.,

PROFESSOR OF GEOLOGY, ROYAL MILITARY AND STAFF COLLEGES, SANDHURST, ETC.

ILLUSTRATED BY FORTY-EIGHT PLATES AND EIGHT HUNDRED AND TWELVE WOODCUTS.

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ALERE FLAMMAM.

DESCRIPTION OF PLATES.

The number of diameters which each object is magnified, is expressed in the Plates by small figures placed beneath the object.

PLATE I.—Test-Objects.

Figure

1. Hairs of the larva of the so-called *Dermestes lardarius*, viewed in balsam.
2. Hairs of the common bat (*Vespertilio pipistrellus*), in balsam. *a, b,* coloured hairs; *c,* a white hair.
3. Hairs of mouse (*Mus musculus*), in balsam.
4. Pits of coniferous wood, common deal (*Abies excelsa*), viewed dry.
5. Mucus- (or salivary) corpuscles, seen under different powers.
6. Scales of *Lepisma saccharina*, dry.
7. Scale from the wing of *Morpho Menelaus*, dry.
8. Scale from underside of wing of common clothes-moth (*Tinea pellionella*), dry.
9. Scales of *Hipparchia janira.* *a,* dry, and by oblique light; *b,* in balsam, by direct light; *c,* dry, after Schacht.
10. *Didymohelix ferruginea*, under different powers; *b,* with imperfect correction or adjustment, *c* with perfect correction and adjustment; *d,* separate fibres.
11. *Didymoprium Grevillii,* empty cells.
12. Scales of *Podura plumbea*, under different powers, dry; *a,* 220 diameters; left hand, three scales as seen when the adjustment of the object-glass is correct and the markings in focus; right hand, scales showing the markings dividing when the adjustments are correct and the focus altered the least possible either way.
13. Pygidium of flea.
14. Frustule of *Grammatophora marina* (diagram). *a,* front view; *b,* side view.
15. Frustule of *Grammatophora subtilissima* (diagram). *a,* front view; *b,* side view.
16. *Gyrosigma angulatum*; dry valve showing the dots.
17. *Gyrosigma attenuatum*; dry valve showing the lines.
18. *Gyrosigma elongatum*; dry valve showing the lines.

PLATE 2.—Arachnida.

Figure

1. *Acarus domesticus* (cheese-mite). *a*, labium and mandibles; *b*, hair; *g*, labium; *i*, end of leg.
2. *Acarus longior.*
3. *Anystis ruricola.* *a*, palp; *b*, mandible of. (See Pl. 41. fig. 4.)
4. Epidermis of *Epeira diadema.*
5. Epidermis of a *Dermanyssus.*
6. Mandibles of *Epeira.*
7. Mandibles &c. of male *Tegenaria.* *a*, *b*, mandibles; *c*, palpi; *d*, maxillæ; *e*, labium.
8. End of leg of *Epeira.* *a*, *b*, hairs of the same.
9. Lung-plates of *Epeira*; 9 *b*, piece more magnified.
10. Spinneret of *Tegenaria domestica.* *a*, two separate spinning-tubes, the right-hand one from *Epeira*, the left-hand one from *Tegenaria.*
11. Portion of cobweb of *Epeira.*
12. Epidermis of *Arrenurus.*
13. *Arrenurus viridis*, female, dorsal view. *a*, palp; *c*, under view of male, showing round mouth with hood and first two joints of palpi, the coxæ, two stigmata and two granular plates, anal orifice and penis.
14. *Atax histrionicus.* *a*, mandible; *b*, palp; *c*, under view, with labium, coxæ, and genital plates.
15. *Hypopus muscarum.*
16. *Sarcoptes hominis*, under view, female.
18. *Psoroptes equi*, under view.
19. *Ixodes Dugesii*, from above.
20. *Ixodes Dugesii*, anterior portion, from above. *a*, dorsal plate; *b*, basilar piece of support of rostrum; *c*, palpi, between which part of mandibles is visible.
21. *Ixodes Dugesii*, side view of palp.
22. *Ixodes Dugesii*, basilar piece from above. *a*, dotted lines indicating first joint of mandibles (*b*) seen through support; *c*, movable toothed claw.
23. *Ixodes Dugesii*, sixth and seventh joints of leg, with claws and caruncle.
24. *Dermanyssus avium*, from beneath. *a*, labium of male, compressed, with palp (*) and mandible (†); *b*, mandible of female; *c*, leg.
25. *Uropoda vegetans.* *a*, mandible; *b*, its end more magnified; *c*, sixth and seventh joint of leg in side view.
26. *Gamasus coleoptratorum*, from above. *a*, end of leg; *b*, body from beneath; *c*, mandible.
27. *Limnochares aquatica.* *a*, under view of labium and palpi; *b*, side view of labium; *c*, tarsus; *d*, scaly plate supporting eyes; *e*, two posterior coxæ of one side only; *f*, rostrum protruded, with palpi and anterior coxæ, trochanters and femora of one side only.
28. *Eylaïs extendens.* *a*, mouth with its hood, and first joint of palps; *b*, palp; *c*, end of mandible, with hook; *d*, under view of body, showing mouth, hood, and one palp, two groups of anterior coxæ with intervening genital orifice and two stigmata, posterior coxæ, anal orifice, and two other stigmata.
29. *Hydrachna globula.* *a*, under view, showing rostrum and palps, coxæ, heart-shaped genital plate and anus; *b*, mandible; *c*, rostrum or labium, with a palp; *d*, palp of larva; *e*, end of leg; *f*, nymphs adherent to *Nepa.*
30. *Diplodontus scapularis.* *a*, labium with palp seen from beneath; *b*, mandible.
31. *Bdella longicornis.* *b*, mandible; *a*, end, more magnified; *c*, mandible of *Bd. cærulipes.*
32. *Tetranychus glaber.* *a*, end of leg, front view, *b*, side view; *c*, palp; *d*, mandible.
33. *Megamerus celer.* *a*, labium; *b*, palp; *c*, mandible of *Megamerus roseus.*
34. *Pachygnathus velutinus.* *a*, palp; *b*, end of leg; *c*, mandible.
35. *Tetranychus cristatus*, vel *lapidum.* *a*, labium of *Raphignathus ruberrimus* with palp and mandibles *in situ*; *b*, mandible of same.
36. *Smaris papillosa*, from above. *a*, mandible.
37. *Trombidium phalangii.* *a*, palpi; *b*, mandible.
38. *Trombidium* (*Leptus*) *autumnale*, from above.
39. *Pteroptus respertilionis*, from above.
40. *Trombidium cinereum.* *a*, labium with a palp; *b*, tarsus; *c*, plume of the labium more magnified; *d*, a mandible.
41. *Scirus* (*Bdella*) *elaphus*, side view. *a*, end of mandible.
42. *Demodex folliculorum*, from beneath.
43. *Demodex folliculorum*, anterior portion from above. *a*, palps; *b*, maxillæ; *c*, labrum *d*, tubercles.

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PLATE 3.—Confervoideæ.

Figure

1. *Chlorococcum vulgare*, Grev. *a*, groups in natural condition; *b*, an isolated cell showing the granular contents; *c*, dividing cells treated with sulphuric acid and iodine.
2. *Protococcus viridis*, nob. *a*, groups of cells, the upper one with eight in a linear series; those to the right with the contents dividing into numerous gonidia (?); *b*, zoospores set free from the cells by the solution of the cellulose membrane; *c*, an isolated cell dividing and about to set free its contents as two zoospores; *d*, resting-cells with a thick coat and reddish contents; *e*, a zoospore with the cilia cast off; *f*, a zoospore with imperfect or retracted cilia; *g*, remains of a zoospore left on a glass slide for twenty-four hours.
3. *Palmella cruenta*, R. Br. *a*, patch of the jelly with single cells, and dividing and divided pairs; *b*, similar cells without the gelatinous layer, the smaller granules similar to those seen in the jelly of *a*; *c*, cells treated with sulphuric acid and iodine, showing the cellulose coat and granular contents; *d*, diagram indicating the relative dimensions of the cells of *Palmella nivalis*.
4. *Glœocapsa polydermatica*, Ktz.
5. *a, b, c, Sarcina ventriculi*, Goodsir.
6. *Coccochloris Brebissonii*, Ktz. *a*, group of cells, some dividing within their cell-coat; *b*, a linear group; *c*, a pair of cells conjugating; *d*, conjugated cells encysted and passing into the resting stage.
7. *Urococcus Hookerianus*, Berk.
8. *a, b, Hydrurus Ducluzelii*, Ag.
9. *Botrydina vulgaris*, Ktz. *a, b, c, d*, successive stages of growth.
10. *Tetraspora gelatinosa*, Ag. Four parent cells producing biciliated zoospores, imbedded in the gelatinous frond.
11. *Gonium pectorale*, Müll. *a*, perfect frond; *b*, the same seen edgewise; *c*, a single zoospore.
12. *Gonium tranquillum*, Ehr.
13. *Glœocapsa ampla*, Ktz.
14. *a, b, Volvox globator ?*, forms related to *Syncrypta* and *Eudorina* of Ehrenberg.
15. *Spirulina oscillarioides* (Turp. ?).
16. *Spirulina Jenneri*, Ktz.
17. *a, Bacterium termo*, Duj.; *b, B. catenula*, D.; *c, B. punctum*, Ehr.; *d, B. triloculare*, Ehr.
18. *Vibrio subtilis*, Ehr.
19. *Vibrio rugula*, Ehr.
20. *Vibrio prolifer*, Ehr.
21. *Vibrio bacillus*, Ehr., probably *Anabaina subtilissima*, Kütz.
22. *Spirochæta plicatilis*, Ehr.
23. *Spirillum volutans*, Ehr.

24–36. *Volvox globator*, L.

24. A perfect family.
25. With fully developed young within.
26. With yellow encysted (resting) spores.
27. Portion of the outer wall, with zoospores, some dividing.
28. Ditto, showing the cilia of the zoospores.
29. Ditto, a fragment after keeping some time in chloride of calcium, the portions around each zoospore tumid.
30. The same seen obliquely, with the cilia.
31. Spore with the protoplasm dividing.
32. Ditto, more advanced.
33. An encysted spore with undivided contents.
34. An encysted resting-spore with yellow contents, probably a subsequent stage of 33.
35. Ditto, ruptured by pressure.
36. A similar resting-spore with conical processes on the outer coat (characterizing the *V. stellatus*, Ehr.).

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PLATE 4.—Confervoideæ.

Figure

1. *Aphanizomenon flos-aquæ*, Morr. *a*, ordinary filaments; *b*, filaments with spermatic cells; *c*, filament with a vesicular cell (*heterocyst*).

2. *Trichormus muscicola*, n. sp. *a*, filament with vesicular cell; *b*, ditto, with adjoining spermatic cells; *c* and *d*, fragments treated with acid to render the membrane and contents distinct; *e* and *f*, spermatic cells similarly treated.

3. *Sphærozyga elastica*, Ag.

4. *Cylindrospermum catenatum*, Ralfs.

5. *Spermosira littoralis*, Harv.

6. *Dolichospermum Ralfsii*, Thwaites.

7. *Nostoc commune*, Vauch. *a*, ordinary filaments; *b*, a single filament in its gelatinous sheath; *c* and *d*, fragments with a vesicular cell.

8. *Oscillatoria autumnalis*, Ag. *a*, fragments escaped from a sheath *b*.

9. *Microcoleus repens*, Harv.; *b*, fragments showing the single sheaths; *c*, *d*, fragments treated with sulphuric acid and iodine.

10. *a*, *b*, *Lyngbya muralis*, Ag.

11. *Dasyglœa amorpha*, Berk.

12. *a*, *b*, *Hassallia ocellata*, Berk.

13. *Schizosiphon Warreniæ*, Caspary. *a*, tuft of filaments; *b*, *c*, fragments; *d*, *e*, decomposing sheaths.

14. *Tolypothrix distorta*, Kütz.

15. *a*, *Ainactis calcarea*, Kütz. *b*, fragment showing the spiral sheath.

16. *Euactis atra*, Kütz.

17. *Schizothrix Creswellii*, Harv.

18. *Rivularia Boryana*, Kütz.

19. *Scytonema Myochrous*, Ag.

20. *Arthronema cirrhosum*, Hass.

21. *Petalonema alatum*, Berk. (*Arthrosiphon Grevillii*, Kütz.). *a*, end of a filament; *b*, cross section.

22. *a*, *Calothrix mirabilis*, Ag.; *b*, junction of filaments.

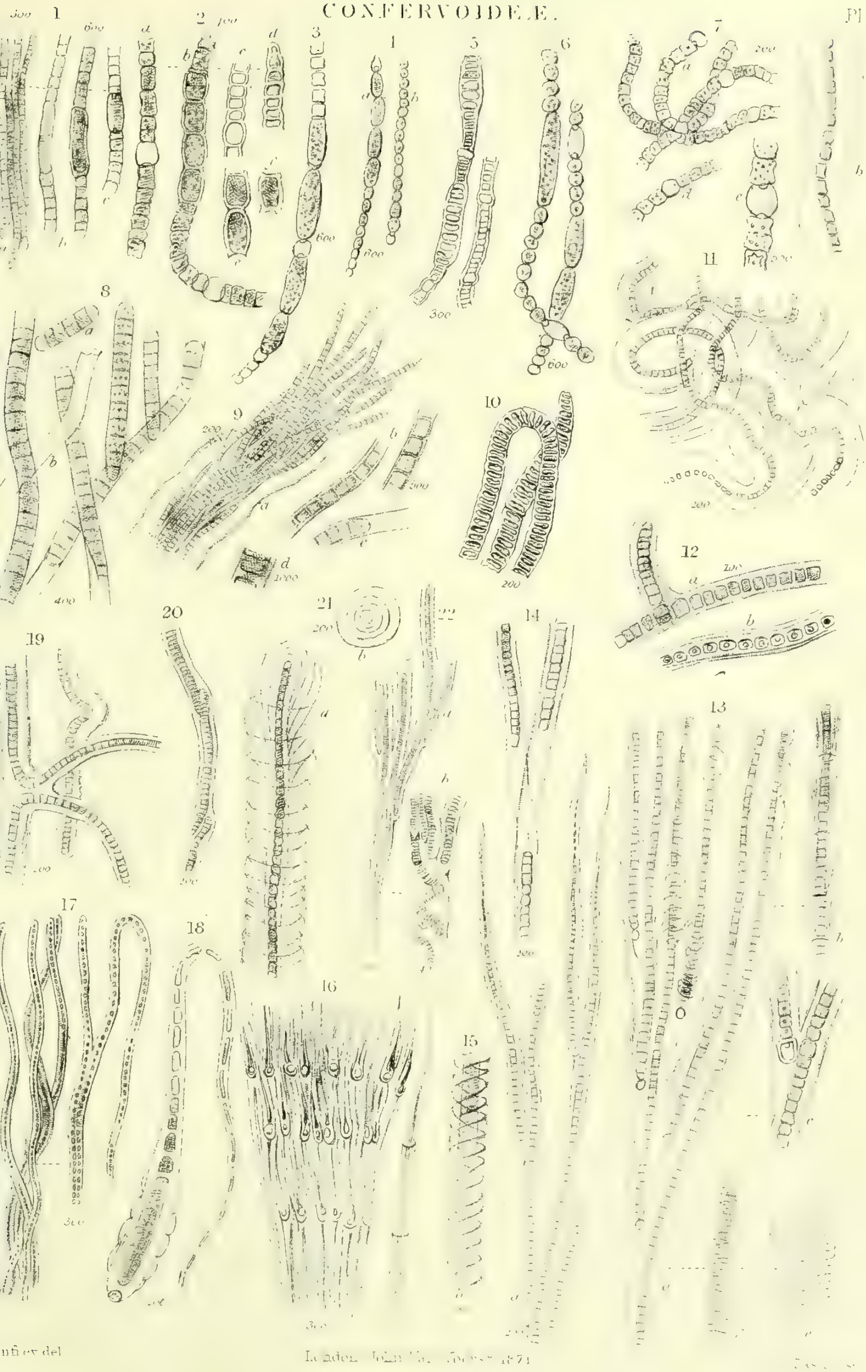

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PLATE 5.—Confervoideæ.

Figure

1. *Monostroma bullosum*, Thuret. *a*, fragment of frond, with some cells empty; *b*, ciliated zoospores from the cells; *c*, zoospore germinating.
2. *Ulva Lactuca*, L. *a*, fragment of frond; *b*, small ciliated zoospores from ditto.
3. Ditto. *a*, fragment of frond; *b*, ditto with the cells nearly empty, showing the orifices by which the zoospores escape; *c*, large zoospore; *d*, zoospores germinating.
4. *Enteromorpha clathrata*, Grev. *a*, fragment of frond; *b*, zoospores from ditto; *c*, the same in germination.
5. *Stigeoclonium protensum*, Kütz. *a* and *b*, fragments of branched filaments, *b*, emitting zoospores, *c*, *c*; *d*, germinating zoospores.
6. *Ulothrix mucosa*, Thur. *a*, *b*, fragments of filaments; *c*, zoospores; *d*, *e*, ditto germinating.
7. *Œdogonium vesicatum*, Link. *a*, fragment of a filament; *b*, ditto, breaking up and emitting a zoospore; *c*, zoospore with a crown of cilia; *d*, *e*, germinating zoospores; *f*, membrane of a zoospore which has burst by a lid and discharged small zoospores immediately after germination; *g*, fragment of a filament with one cell containing a resting-spore; *h*, fragment of a filament in an abnormal state, containing globular bodies; *i*, germinated zoospore containing similar globular bodies.
8. *Chætophora elegans*, Ag.
9. A fragment of the same, emitting zoospores.
10. *Conferva ærea*, Dillw. *a*, fragment of filament, one cell of which has discharged its contents in the form of zoospores, *b*.
11. *Conferva floccosa*, Thur. *a*, filament breaking up; *b*, fragment of growing filament; *c*, zoospores.
12. *Rhizoclonium obtusangulum*, Kütz.
13. *Cladophora glomerata*, Kütz. *a*, filament with one fertile branch; *b*, apex of a fertile branch discharging zoospores, *c*.
14. *Sphæroplea annulina*, Kütz. *a*, growing filament; *b*, filament with the contents converted into spores.
15. *Codium tomentosum*, Ag. *a*, apex of clavate branch, with fertile cell; *b*, zoospores.
16. *Staurocarpus gracilis*, Hass.; conjugating filaments.

17–23. *Spirogyra quinina*, Kütz.; 17, growing filament.

18. Conjugating filaments, with spores.
19. Ditto, with the spores germinating.
20. Half-decomposed cell, with the contents converted into almost colourless biciliated zoospores.
21. Spore formed after conjugation.
22. The same shortly before germination.
23. A similar spore, with the contents converted into globular bodies.
24. *a* and *b*, portions of a *Spirogyra*? with the contents converted into spiny globular bodies.
25. *Spirogyra quinina*, Kütz.; imperfectly conjugated cells, with the contents converted into globular bodies.
26. *Spirogyra nitida*; cell with nucleus, *n*.
27. *Spirogyra pellucida*, Kütz.; cell with nucleus, *n*, and gelatinous outer coat, *s*.
28. *Spirogyra nitida*, Kütz., half-decayed, the contents partly changed into globular masses.

CONFERVOIDEÆ

PLATE 6.—**Confervoideæ.—Crystals.**

Figure

1. *Cosmarium margaritiferum*, Turp.: conjugating pair with imperfect sporange.
2. *Cosmarium botrytis*, Bory; conjugating pair with sporange, enveloped in jelly.

3 A. *Closterium acerosum*, Schrank. *a*, *b*, *c*, different stages of conjugation; *d*, frustules apparently produced from a sporange.

3 B. *Closterium lunula*, Müll.; the contents converted into globular bodies.

4. *Fragilaria penicillata*, Lyngb. *a* and *b*, successive stages of conjugation.

5. A. *Surirella bifrons*, Ehr.; conjugating pair, with intermediate large sporangial frustule.

5. B. *Surirella bifrons*, Ehr., with the contents converted into globular bodies.

6. *Eunotia turgida*, Ehr. *a*, *b*, *c*, *d*, *e*, successive stages of conjugation producing pairs of sporangial frustules.
7. *Melosira* (*Aulacosira*) *crenulata*, Thw. *a*, filament with two conjugating pairs of cells and perfect sporangial frustules; *b* and *c*, large filaments produced by sporangial frustules.
8. *Melosira varians*, Ag. *a*, small filament producing sporangial frustules by conjugation; *b*, large filament developed from sporangial frustules.
9. *Orthosira Dickiei*, Thw. Successive stages of production of sporangial frustules after conjugation.
10. *Pinnularia viridis*, Sm., with the contents converted into globular bodies.
11. *Pediastrum granulatum*, Ktz. *a*, a frond with most of the cells empty, three full, and the contents of another swarming out as zoospores; *b*, *c*, *d*, swarm of zoospores producing a new frond.
12. Crystals of sugar of milk.
13. " diabetic sugar.
14. " indigo, sublimed.
15. " oxalate of soda.
16. " sulphate of lime.
17. " phosphate of lime.
18. " sulphate of strontia.
19. " nitrate of soda.
20. " allantoin.
21. " antimoniate of soda.
22. " protoxide of antimony.
23. " butyrate of baryta. *a*, rapidly, *b*, slowly formed.
24. " hydrofluosilicate of baryta.
25. " sulphate of baryta. *a*, precipitated from concentrated, *b*, from very dilute solution.
26. " carbonate of potash.

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PLATE 7.—**Crystals.**

Figure

1. *a*, brucia; *b*, sulphocyanide of brucia.
2. Cinchonine.
3. Sulphocyanide of cinchonine.
4. Narcotine.
5. *a*, *b*, Strychnine.
6. Sulphocyanide of strychnine.
7. Morphia.
8. Sulphocyanide of quinine.
9. Muriate of ammonia.
10. Purpurate of ammonia (murexide).

11., 12. Nitrate of potash (ANALYTIC CRYSTALS).

13. Benzoic acid. *a*, crystallized from water; *b*, sublimed.
14. Lithofellinic acid.
15. Margarine.
16. Stearic acid; *a*, margaric acid.
17. Iodo-disulphate of quinine.
18. Hippuric acid.
19. Lactate of lime.
20. Lactate of zinc.
21. Succinic acid crystallized from water.
22. Creatine.
23. Creatinine.
24. Compound of creatinine and chloride of zinc.

PLATE 8.—**Crystals from Animal Secretions.**

Figure

1. Uric acid, human, natural. *a*, rhombs, front view ; *b*, side view ; *c*, *d*, striated ; *e*, rhombs with obtuse angles truncated ; *f*, twin crystals ; *g*, ditto ; *h*, hour-glass crystals ; *i*, nucleated ditto ; *k*, *l*, *m*, *n*, *o* (and lower *h*), aigrettes ; *p*, large dumb-bell forms.

2. Uric acid, human, natural. *a*, front, *b*, side view.

3. Uric acid, coloured artificially by murexide.

4. Uric acid, natural. *a*, front, *b*, side view ; *c*, aigrette.

5. Uric acid, precipitated from solution in sulphuric acid by water.

6. Uric acid, rhombs, slightly acted upon with potash, showing spurious nuclei.

7. Uric acid, precipitated from gout-stones.

8. Uric acid of *Boa*, artificially precipitated. *a*—*d*, from solution in sulphuric acid by water ; *e*—*h*, from solution in potash by muriatic acid.

9. Uric acid, precipitated from the excrement of the tortoise.

10. Uric acid, precipitated :—*a*, from the excrement of the clothes-moth ; *b*, from stag-beetle (*Lucanus cervus*).

11. Urate of soda and ammonia. *a*, spheres with nuclei and concentric rings, artificial ; *b*, surface covered with radiating needles ; *c*, *d*, *e*, natural forms ; *f*, *g*, artificial.

12. Urates of soda and ammonia. *a*, artificial urate of ammonia, deposited on cooling of an aqueous solution ; *b*, natural urate of soda, as composing the chalky matter around gouty joints.

13. *a*, *b*, Urate of lime.

14. *a*, *b*, Urate of magnesia.

15. Uric acid, precipitated by an acid from human urine.

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PLATE 9.—Crystals from Animal Secretions.

Figure

1. Various prismatic forms of the ammonio-phosphate of magnesia (triple phosphate), naturally formed in human secretions.
2. Feathery or penniform crystals of the same salt.
3. Stellate form of the same salt.
4. Minute imperfectly formed prisms of the same.
5. Cystic oxide.
6. Carbonate of lime deposited from water by standing.
7. Carbonate of lime from the urine of the horse, natural.
8. Carbonate of lime from the urine of man, natural.
9. Octahedra of oxalate of lime, as seen in water.
10. Octahedra of oxalate of lime, as seen when dried.
11. Ellipsoidal forms of oxalate of lime, natural.
12. Ellipsoidal constricted, or dumb-bell forms of the same, natural.
13. Crystals of oxalate of lime, prepared with acid.
14. Modified octahedra of the same salt, formed by double decomposition.
15. Crystals of bilifulvine, natural, human.
16. Crystals of hæmatoidine.
17. Crystals of urea.
18. Nitrate of urea. *a*, *b*, slowly, *c*, rapidly formed.
19. Oxalate of urea.
20. Uroglaucine.
21. Cholesterine.

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PLATE 10.—Desmidiaceæ.

Figure

1. *Hyalotheca dissiliens,* front view.
2. *Hyalotheca dissiliens,* side or end view.
3. } *Hyalotheca dissiliens,* conjugating cells, with sporangia.
4. }
5. *Didymoprium Grevillii,* front view.
6. *Didymoprium Grevillii,* side view.
7. *Desmidium Swartzii,* front view.
8. *Desmidium Swartzii,* side view.
9. *Sphærozosma vertebratum,* front view.
10. *Sphærozosma vertebratum,* side view.
11. *Micrasterias denticulata,* cell dividing.
12. *Micrasterias denticulata,* sporangium.
13. *Micrasterias rotata.*
14. *Euastrum verrucosum.*
15. *Euastrum oblongum.*
16. *Euastrum didelta.*
17. *Euastrum didelta,* cell free from contents.
18. *Cosmarium pyramidatum.*
19. *Cosmarium pyramidatum,* empty cell.
20. *Cosmarium crenatum.*
21. *Cosmarium margaritiferum.*
22. *Cosmarium tetraophthalmum.*
23. *Xanthidium armatum.*
24. *Xanthidium armatum,* empty cell.
25. *Xanthidium fasciculatum.*
26. *Staurastrum dejectum.*
27. *Arthrodesmus convergens.*
28. *Staurastrum margaritaceum,* front view.
29. *Staurastrum margaritaceum,* side view.
30. *Staurastrum gracile,* front view.
31. *Staurastrum gracile,* side view.
32. *Staurastrum furcigerum,* front view; fig. 56, side view.
33. *Tetmemorus granulatus.*
34. *Tetmemorus granulatus,* empty cell.
35. *Tetmemorus lævis,* in conjugation.
36. *Penium Brebissonii.*
37. *Penium margaritaceum,* empty cell.
38. *Docidium truncatum.*
39. *Docidium baculum.*
40. *Closterium lunula.*
41. *Closterium acerosum.*
42. *Closterium acerosum,* in conjugation.
43. *Closterium moniliferum.*
44. *Closterium didymotocum.*
45. *Closterium setaceum.*
46. *Closterium setaceum,* in conjugation.
47. *Ankistrodesmus falcatus.*
48. *Pediastrum Boryanum.*
49. *Pediastrum granulatum,* empty cell.
50. *Scenedesmus quadricauda.*
51. *Scenedesmus obliquus.*
52. *Aptogonum desmidium,* side view; fig. 55, front view.
53. *Scenedesmus obtusus,* just after division.
54. *Scenedesmus obtusus,* ordinary state.
55. *Aptogonum desmidium,* front view; fig. 52, side view.
56. *Staurastrum furcigerum*; *a,* side view; fig. 32, front view.
57. *Closterium Griffithii.*
58. ,, ,,
59. *Spirotænia condensata.*

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PLATE 11.—**Diatomaceæ.**

The figures represent the prepared frustules or valves, except when otherwise stated.

Figure

1. *Pinnularia nobilis,* side view.
2. *Pinnularia viridis,* side view, with endochrome.
3. *Pinnularia oblonga,* side view.
4. *Pinnularia radiosa,* side view.
5. *Pinnularia radiosa,* front view.
6. *Navicula cuspidata,* side view.
7. *Navicula cuspidata,* front view.
8. Portion of the valve of a *Navicula,* showing the transverse rows of dots.
9. *Navicula didyma,* side view.
10. *Gyrosigma balticum,* side view.
11. Hoop of the same, side view.
12. *Gyrosigma strigilis,* side view.
13. *Gyrosigma hippocampus,* side view.
14. *Gyrosigma acuminatum,* side view.
15. *Gyrosigma attenuatum,* side view.
16. *Gyrosigma attenuatum,* front view.
17. *Gyrosigma Spencerii,* side view.
18. *Gyrosigma lacustre,* side view.
19. *Gyrosigma littorale,* side view.
20. *Gyrosigma distortum,* side view.
21. *Gyrosigma fasciola,* side view.
22. *Gyrosigma macrum,* side view.
23. *Gyrosigma prolongatum,* side view.
24. *Gyrosigma tenuissimum,* side view.
25. *Gyrosigma formosum,* side view.
26. *Gyrosigma decorum,* side view.
27. *Gyrosigma obscurum,* side view.
28. *Gyrosigma speciosum,* side view.
29. *Gyrosigma strigosum,* side view.
30. *Gyrosigma rigidum,* side view.
31. *Gyrosigma elongatum,* side view.
32. *Gyrosigma delicatulum,* side view.
33. *Gyrosigma angulatum,* side view. *a,* with endochrome; *b,* variety β; *c,* variety γ, end of.
34. *Gyrosigma quadratum.*
35. *Gyrosigma æstuarii.*
36. *Gyrosigma intermedium.*
37. *Gyrosigma transversale.*
38. *Gyrosigma transversale.*
39. Portion of valve of *G. balticum.*
40. Portion of valve of *G. strigosum.*
41. Portion of valve of *G. angulatum* (DIATOMACEÆ).
42. Portion of valve of *G. littorale.*
43. *Stauroneis phœnicenteron,* side view.
44. *Stauroneis pulchella,* side view.
45. *Stauroneis pulchella,* front view.
46. *Gyrosigma angulatum,* showing the dots as pearls.

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PLATE 12.—Diatomaceæ.

Figure

1. *Achnanthes longipes*; the front view of the frustules is visible.
2. *Achnanthes longipes*, side view, upper valve.
3. *Achnanthes longipes*, side view, lower valve.
4. *Achnanthes exilis.*
5. *Achnanthidium microcephalum*, side and front views.
6. *Achnanthidium flexellum*, front and side views.
7. *a*, *Amphipleura pellucida*, side view of frustule: *b*, *Amphipleura pellucida*, single valve; *c*, *Amphipleura sigmoidea*.
8. *Amphiprora alata.* *a*, side view; *b*, front view.
9. *Amphitetras antediluviana.* *a*, frustules united; *b*, side view; *c*, front view; *d*, perspective view.
10. *Amphora ovalis*, front view; 10 *a*, transverse section.
11. *Amphora membranacea*; front view of single valve.
12. *Arachnoidiscus Ehrenbergii*, side view.
13. *Arachnoidiscus Ehrenbergii*, portion of valve from the centre to the circumference.
14. *Bacillaria paradoxa.* *a*, front view of conjoined frustules; *b*, side view; *c*, front view of single frustule. (See also Pl. 43. fig. 17.)
15. *Biddulphia pulchella*, front view. *a*, frustule dividing, front view.
16. *Campylodiscus costatus*, side view. *b*, front view.
17. *Cocconeis pediculus.*
18. *Cocconeis scutellum*, single valve (side view).
19. *Cocconema lanceolatum.*
20. *Cocconema lanceolatum*, single valve (side view).
21. *Cyclotella operculata.* *a*, side view; *b*, front view.
22. *Cyclotella Kutzingiana*, front view.
23. *Sphinctocystis* (*Cymatopleura*) *solea.* *a*, side view; *b*, front view.
24. *Sphinctocystis* (*Cymatopleura*) *elliptica*, side view.
25. *Denticula obtusa.* *b*, front view; *c*, side view of single frustule; *d*, front view of the same.
26. *Diatoma vulgare*, connected frustules. *a*, side view; *b*, front view of single frustule.
27. *Diadesmis confervacea.* *a*, front view; *b*, side view.
28. *Meridion constrictum.* *a*, connected frustules forming a coil; *b*, front view of single frustule.
29. *Doryphora amphiceros.* *a*, side view of frustule with endochrome; *b*, front view; *c*, prepared single valve.
30. *Eupodiscus argus.* *a*, side view; *b*, front view; *c*, fragment, more highly magnified.
31. *Eupodiscus sculptus*, side view.
32. *Epithemia turgida.* *a*, side view; *b*, front view.
33. *Fragilaria capucina*; side view of frustule, front view of the same, and frustules united into a filament.
34. *Gomphonema acuminatum.* *b*, side view; *c*, front view of frustule.
35. *Grammatophora marina*, connected frustules. *b*, single frustule, front view; *c*, side view.
36. *Himantidium pectinale*, united frustules, front view. *a*, side view of single frustule; *b*, side view of variety β; *c*, sporangial frustule.

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PLATE 13.—Diatomaceæ.

Figure

1. *Hyalosira rectangula,* front view of connected frustules.
2. *Isthmia enervis,* front view.
3. *Licmophora splendida.* *b,* side view; *c,* front view of single frustule.
4. *Lithodesmium undulatum.* *a,* front view; *b,* side view.
5. *Melosira nummuloides,* front view.
6. *Melosira varians,* front view. *a,* side view.
7. *Meridion circulare.* *a,* frustules united into a coil, front view; *b,* side view of single frustule.
8. *Micromega parasiticum,* natural size. *b,* portion of a filament containing the frustules; *c,* side view, *d,* front view of a frustule.
9. *Nitzschia sigmoidea.* *a,* side view; *b,* front view.
10. *Nitzschia lanceolata.* *a,* front view; *b,* separate valve; *c,* side view of the same; 10 *d,* portion of valve, showing the dots.
11. *Nitzschia longissima.* *a,* side view; *b,* front view.
12. *Nitzschia reversa,* front view of single valve.
13. *Nitzschia.* *a, tænia*; *b, acicularis.*
14. *Odontidium turgidulum.* *a,* frustules united, front view; *b,* single valve, side view.
15. *Orthosira Dickieii.* *a,* front view; *b,* side view.
16. *Pododiscus jamaicensis.* *a,* side view; *b,* front view.
17. *Podosphenia Ehrenbergii.* *a,* front view; *b,* side view of single frustule.
18. *Rhabdonema arcuatum.* *a,* united frustules, front view; *b,* side view of single frustule. See also Pl. 43. fig. 69.
19. *Rhipidophora paradoxa.* *b,* front view of single frustule; *c,* side view of the same.
20. *Striatella unipunctata.* *a,* front view; *b,* the same; *c,* side view.
21. *Surirella gemma.* *a,* side view; *b,* front view.
22. *Surirella bifrons.* *a,* front view; *b,* side view.
23. *Synedra splendens.* *a,* attached frustules; *b,* side view of prepared frustule; *c,* front view of the same.
24. *Synedra fulgens.* *a,* side view; *b,* front view of a prepared frustule.
25. *Synedra capitata,* side view.
26. *Sphenosira catena.* *a,* united frustules, front view; *b,* side view of single frustule.
27. *Tabellaria flocculosa.* *a,* united frustules, front view; *b,* side view of single frustule.
28. *Tetracyclus lacustris,* united frustules, front view. *a,* side view.
29. *Triceratium favus.* *a,* side view; *b,* front view.
30. *Tryblionella scutellum,* side view.
31. *Tryblionella gracilis,* front view.
32. *Tryblionella gracilis,* diagram of transverse section.

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PLATE 14.—Diatomaceæ and Entomostraca.

Figure

1. *Acroperus nanus.* 2. *Acroperus harpæ.*
3. *Alteutha depressa.* *a*, first pair of legs.
4. *Alona reticulata.* 5. *Alona quadrangularis.*
6. *Anomalocera Patersonii*, male.
7. *Anchorella uncinata.* *a*, arms; *b*, abdomen; *c*, ovarian tubes.
8. *Berkeleya fragilis.* *a*, natural size; *b*, portion of a branch containing frustules; *c*, side view, *d*, front view of a single frustule.
9. *Biddulphia aurita.* Frustules undergoing division: *a*, hoop of original frustule, to which two new halves (*c*) have been formed; the hoop of the new frustules is seen at *b*; the hoop of the parent has separated from the two frustules *d d*, which are perfectly formed, each with its new hoop.
10. *Encyonema prostratum.* *a*, frustules contained in a gelatinous tube, side view; *b*, front view; *c*, separate frustules, side view.
11. *Raphidoglœa micans.* *a*, natural size; *b*, group of frustules; *c*, single frustule, front view.
12. *Schizonema Dillwynnii.* *a*, natural size; *b*, filaments containing frustules; *c*, front view, *d*, side view of frustule.
13. *Zygoceros rhombus.* *a*, front view; *b*, side view.
14. *Syncyclia salpa*; frustules immersed in a gelatinous mass.
15. *Homœocladia anglica.* *a*, portion of the natural size; *b*, part of a filament containing two frustules; *c*, front view, *d*, side view of a prepared frustule.
16. *Dickieia ulvoides.* *a*, natural size; *b*, portion of frond containing frustules; *c*, *d*, *f*, prepared frustules, front view; *e*, side view.
17. *Frustulia saxonica*; frustules immersed in a gelatinous mass.
18. *Cymbosira Agardhii.* *a*, united frustules; *b*, front view; *c*, side view of prepared frustules.
19. *Sphenella vulgaris.* *a*, front view; *b*, side view.
20. Spermatozoa of a *Cypris*.
21. *Cetochilus septentrionalis*, dorsal view.
22. *Notodelphys ascidicola*, female. 23. *Lepeophtheirus pectoralis*, female.
24. *Lerneonema spratta*, female. 25. *Macrothrix laticornis*, female.
26. *Moina rectirostris*, female. 27. *Sida crystallina.*
28. *Nebalia bipes.* 29. *Polyphemus pediculus.*
30. *Evadne Nordmanni.*
31. *Peracantha truncata.* *a*, superior antenna.
32. *Pleuroxus trigonellus.*
33. *Terpsinoe musica*: front view, Pl. 19. fig. 10.
34. *Podosira hormoides*, front view. 35. *Tessella interrupta*, front view.
36. *Nicothoe astaci.* *a*, ovaries.
37. *Cythere lutea.* Poison-gland, *a*, and urticating organ, *b*.

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PLATE 15.—**Entomostraca.**

Figure

1. *Argulus foliaceus*, seen from beneath. *a*, anterior, *b*, posterior antennæ; *c*, rostrum; *d*, suckers, representing the first pair of legs; *e*, second pair of legs; *f*, four posterior pairs of legs.
2. *Bosmina longirostris*; 2*, the same, natural size.
3. *Branchipus stagnalis*.
4. *Camptocercus macrourus*.
5. *Cypris reptans*; 5 *a*, inferior antenna.
6. *Canthocamptus minutus*; 6 *a*, inferior antenna; 6 *b*, first pair of foot-jaws; 6 *c*, second pair of foot-jaws.
7. *Chydorus sphæricus*.
8. *Cyclops quadricornis*, male. *a*, *b*, superior antennæ.
9. *Cyclops quadricornis*, female. *a*, superior, *b*, inferior antennæ; *c*, external ovaries.
10. *Cyclops quadricornis*, inferior antenna.
11. *Cyclops quadricornis*, mandible; *a*, body; *b*, serrated seta; *c*, filaments of palp.
12. *Cyclops quadricornis*, first pair of foot-jaws.
13. *Cyclops quadricornis*, second pair of foot-jaws: 13 *a*, internal portion; 13 *b*, external portion.
14. *Cyclops quadricornis*, first pair of thoracic legs.
15. *Cyclops quadricornis*, fifth pair of legs.
16. *Cyclops quadricornis*, recently hatched.
17. *Cypris tristriata*.
18. *Cypris tristriata*, superior antenna.
19. *Cypris tristriata*, inferior antenna.
20. *Cypris tristriata*, mandible.
21. *Cypris tristriata*, first pair of jaws; *a*, basal plate; *b*, branchial lamina.
22. *Cypris tristriata*, second pair of jaws.
23. *Cypris tristriata*, first pair of legs.
24. *Cypris tristriata*, second pair of legs.
25. *Cypris tristriata*, lateral half of the abdomen.
26. *Cythere inopinator*.
27. *Daphnella Wingii*.
28. *Daphnia pulex*. *a*, superior antennæ; *b*, inferior antennæ; *c*, heart.
29. *Daphnia pulex*, first pair of legs.
30. *Daphnia pulex*, second pair of legs.
31. *Daphnia pulex*, third pair of legs.
32. *Daphnia pulex*, fourth pair of legs.
33. *Daphnia pulex*, fifth pair of legs.
34. *Daphnia pulex*, mandible.
35. *Daphnia pulex*, labrum.
36. *Daphnia pulex*, jaw.
37. *Daphnia reticulata*. *a*, ephippium.
38. *Diaptomus castor*.
39. *Eurycercus lamellatus*.

ENTOMOSTRACA.

Pl 15.

London. John [illegible]

PLATE 16.—Entozoa.

Figure

1. *Echinococcus veterinorum* (*hominis*); 1 *a*, in the contracted state; 1 *b*, hooks; 1 *c*, *d*, *f*, in the expanded state; 1 *e*, imperfectly developed individual.
2. *Echinococcus veterinorum* (*hominis*), cyst reproducing by external gemmation.

3 *a*. *Cysticercus cellulosæ*, nat. size; 3 *b*, *C. fasciolaris*, head of.

4. *Anguillula fluviatilis.*
5. *Anguillula aceti.*
6. *Anguillula tritici.* *a*, *b*, ova; *c*, mature individual; *d*, *e*, imperfectly developed individuals.
7. *Gyrodactylus auriculatus*, 8 diameters.
8. *Ascaris vermicularis*; 8 *a*, head; 8 *b*, body; *d*, stomach; *e*, œsophagus; *g*, anus; *h*, ovaries; *k*, oviduct.

9 *a*. *Ascaris lumbricoides*, front view of head; 9 *b*, tail of male, with spicula; 9 *c*, side view of head.

10. *Cœnurus cerebralis*, portion of a cyst.
12. *Tænia solium*, head of, side view; two of the suckers only are visible.
13. *Tænia solium*, head of, front view; all the four suckers are visible.
14. *Tænia solium*, a single joint, injected. *a*, gastric (?) canals; *b*, vascular canals; *c*, testicular capsule; *d*, spermatic duct; *e*, oviduct; the dark ramified organ is the ovary.
15. *Tænia solium*, ovum of.
16. *Trichina spiralis*, lying within its cyst, imbedded in muscle.
17. *Trichina spiralis*, removed from its cyst.
18. *Trichina spiralis*, internal organs.
19. *Trichocephalus dispar*, male.
20. *Trichocephalus dispar*, portion of the neck.
21. *Trichocephalus dispar*, female; 21 *a*, ovum.
22. Ovum of *Monostoma verrucosum.*
23. Ovum of *Tænia variabilis.*
25. *Gregarina sipunculi.*
26. *Gregarina sipunculi*, with two enclosed cells.
27. Caudate pseudo-navicula, from the abdominal cavity of *Sipunculus nudus.*
28. *Gregarina Sieboldii.*
29. Young pseudo-navicula cyst of *Gregarina sænuridis*, from testis of *Sænuris variegata*, consisting of two loosely connected ovate cells, without an outer envelope.
30. The same, with an outer envelope.
31. More advanced pseudo-navicula cyst of the same *Gregarina*, with two cells containing rounded pseudo-naviculæ.
32. The same, with elongated pseudo-naviculæ; the cyst has three cell-like bodies on its surface.
33. The same with a single cavity, containing elongated pseudo-naviculæ.
34. Two *Gregarinæ sænuridis*, adherent by their ends.
35. *Echinorhynchus anthuris*, head, 25 diameters.

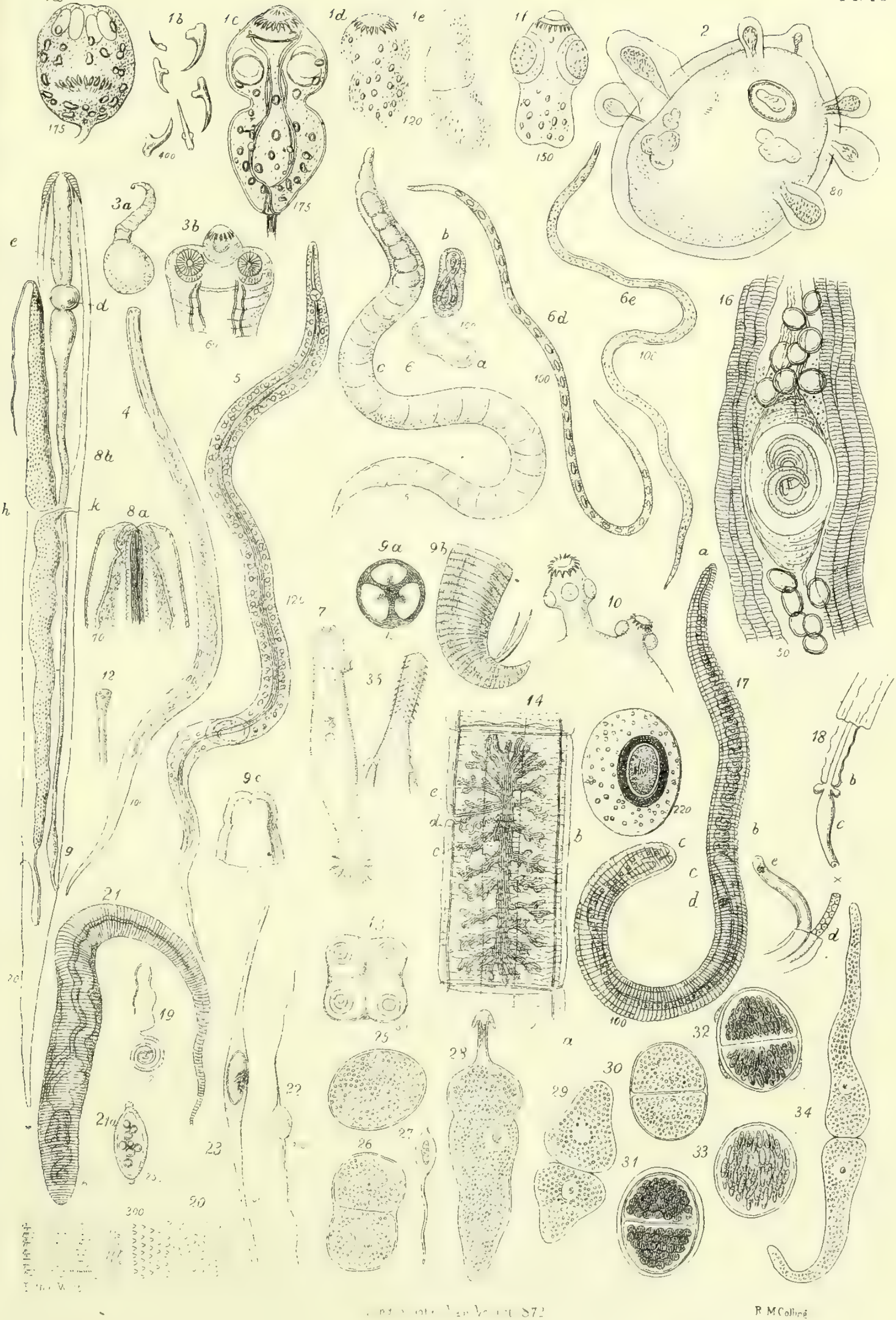

PLATE 17.—**Fish-scales, etc.**

Figure

1. Scale of sturgeon, perpendicular section. *a*, outer spongy portion; *b*, inner laminated portion; 1 *c*, transverse section of outer portion.
2. Skin of thornback-skate (*Raia clavata*), viewed from above.
3. Large spine of skate, side view.
4. Portion of transverse section of large spine of skate (fig. 3 *b*).
5. Longitudinal section of tooth of a small spine of skate (fig. 2).
6. Scale of perch (*Perca fluviatilis*).
7. Perch-scale, portion of (fig. 6 *a*), more magnified.
8. Perch-scale, portion of (fig. 6 *b*), more magnified.
9. Scale of sole (*Solea vulgaris*).
10. Scale of roach (*Leuciscus rutilus*).
11. Scale of roach (*Leuciscus rutilus*), portion of surface more highly magnified.
12. Scale of roach (*Leuciscus rutilus*), perpendicular section.
13. Scale of minnow (*Leuciscus phoxinus*).
14. Feather of finch; shaft with medullary cells.
15. Feather of goose (*Anser cinereus*). *a*, pinnæ with hooks; *b*, pinnæ with teeth; *c*, barbs.
16. Separate pinnæ. *a*, with hooks; *b*, with teeth.

17.\
18. } Feather (downy), free barbs of.

19. Skin of eel (*Anguilla vulgaris*), with stellate pigment-cells, and indications of subjacent scales.
20. Scale of eel (*Anguilla vulgaris*). 20 *a*, portion, more magnified.
21. Calcareous corpuscles from the same, left after red heat.
22. Scale of jack or pike (*Esox lucius*).
23. Scale of dace (*Leuciscus vulgaris*).
25. Leech (*Hirudo medicinalis*), anterior sucker of.
26. Leech, jaw of, side view. *a b*, teeth; *c*, fibro-cartilaginous substance of jaw; *d*, pigment-cells.
27. Leech, jaw of, the free margin turned towards the observer.
28. Leech, teeth of. *a*, side view; *b*, front view.
29. Horn of cow. *a*, section parallel to surface; *b*, cells softened by potash, *d*, containing pigment; *e*, perpendicular section; *f*, cracks between laminæ; *g*, edges of divided laminæ.
30. Whalebone, longitudinal section.
31. Whalebone, transverse section.
32. Whalebone, longitudinal section of hair of.
33. Whalebone, cells of, resolved by potash.
34. Fish, crystals from scales of.
35. Muscular fibres of lobster (*Astacus marinus*).
36. Muscular fibrillæ, various appearances presented by.
37. Large spine of skate, outer portion of.

Figure
1. *Miliola obesa* (young or "Adelosine" condition).
2. *Uniloculina indica.* *a,* side view; *b,* end view.
3. *Biloculina ringens.*
4 *a, b.* *Triloculina trigonula.*
5 *a, b.* *Quinqueloculina seminulum.*
6 *a, b.* *Quinqueloculina Brongniartii.*
7. *Spiroloculina planulata.*
8 *a, b.* *Hauerina compressa.*
9 *a, b.* *Articulina gibberula.*
10. *Vertebralina striata.*
11 *a, b.* *Peneroplis pertusus.*
12 *a, b.* *Spirolina austriaca.*
13. *Cornuspira foliacea,* magn. 8 diameters.
14. *Trochammina incerta,* magn. 25 diameters.
15. *Alveolina fusiformis.*
16 *a, b.* *Alveolina rotella.*
17 *a, b.* *Orbitolites complanatus,* natural size.
18 *a, b.* *Lituola difformis,* side view. Somewhat abraded.
19. *Orbiculina adunca.*
20. *Valvulina austriaca.*
21 *a, b.* *Nubecularia rugosa.*
22 *a, b.* *Lagena lævis,* transverse section.
23 *a, b.* *Entosolenia globosa.*
24. *Lagena striata* (apiculate).
25. *Lagena semistriata.*
26. *Lagena squamosa.*
27. *Lagena scalariformis.*
28 *a, b.* *Glandulina lævigata.*
29. *Nodosaria raphanus,* var.
30. *Marginulina raphanus.*
31. *Marginulina raphanus* (inside of the shell).
32. *Marginulina raphanus* (sarcode, without the shell).
33. *Dentalina communis.*
34. *Cristellaria simplex.*
35 *a, b.* *Vaginula badenensis.*
36 *a, b.* *Orthocerina quadrilatera.*
37 *a, b.* *Cristellaria cultrata.*
38 *a, b.* *Flabellina rugosa.*
39. *Frondicularia spathulata* (fragment).
40 *a, b.* *Polymorphina communis.*
41. *Polymorphina Orbignii* (*tubulosa*).
42. *Polymorphina oblonga.*
43. *Polymorphina compressa.*
44. *Uvigerina pygmæa.*
45 *a, b.* *Cassidulina lævigata.*
46. *Bulimina pupoides.*
47 *a, b.* *Textularia cuneiformis.*
48 *a, b.* *Gaudryina pupoides.*
49 *a, b.* *Vulvulina gramen.*
50 *a, b.* *Bigenerina agglutinans.*
51 *a, b.* *Clavulina* (*Valvulina*) *parisiensis.*
52. *Textularia annectens.*
53. *Dactylopora eruca.*
54. *Dactylopora reticulata.*
55. *Polystomella crispa,* the body (sarcode) of. Magn. 15 diameters.
56. Coccospheres, *a*; coccoliths, *b, c, d.* Highly magnified.

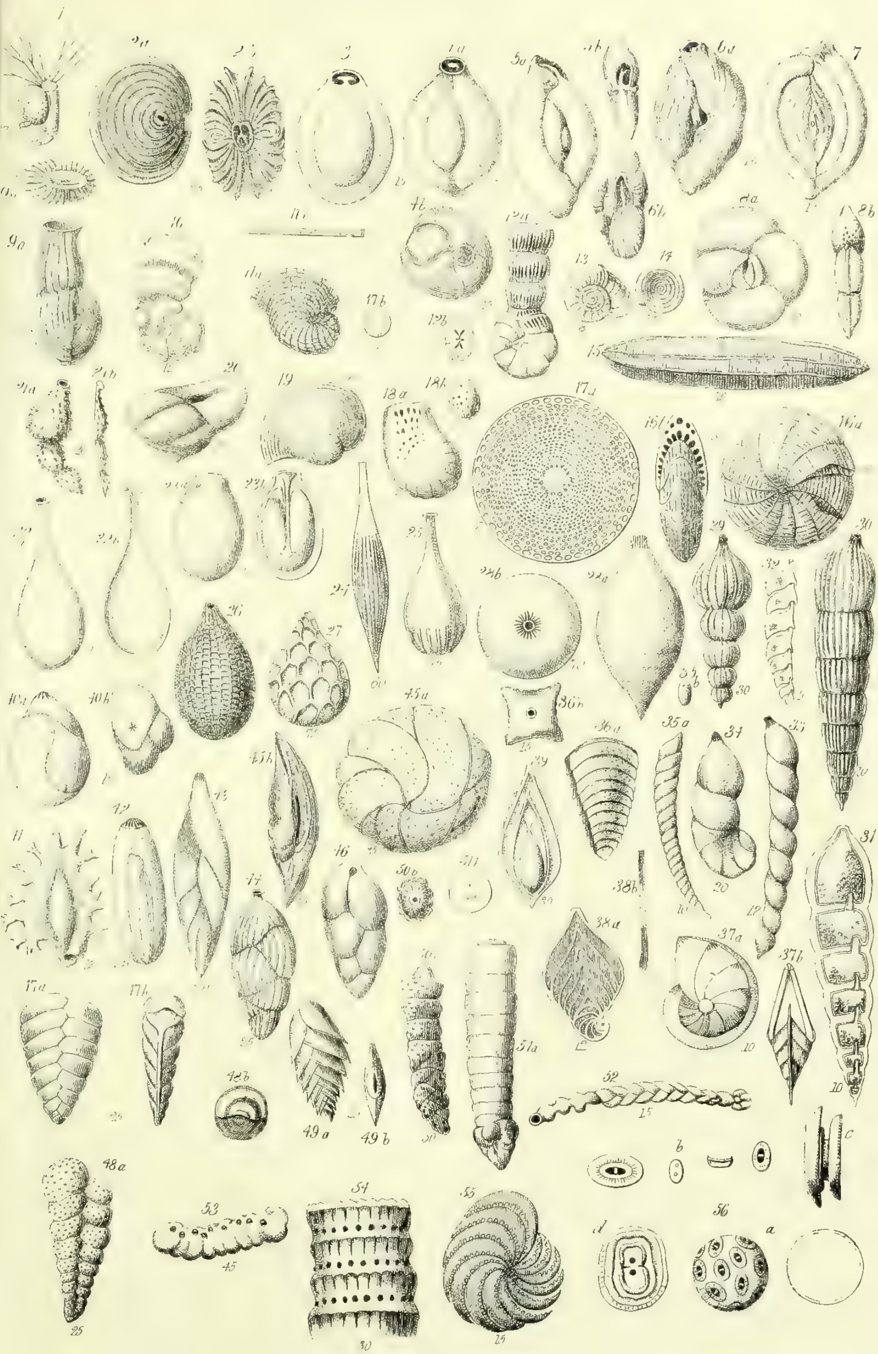

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PLATE 19.—**Fossils.**

Figure

1. *Mesocena octogona.*
2. *Asteromphalus Hookerii,* side view.
3. *Hemiaulus antarcticus,* front view.
4. *Heliopelta Leeuwenhoeckii,* side view.
5. *Asterolampra marylandica,* side view.
6. *Symbolophora trinitatis,* side view.
7. *Coscinodiscus craspedodiscus,* side view.
8. *Coscinodiscus craspedodiscus,* half a valve.
9. *Climacosphenia moniligera.* *a,* side view; *b,* front view.
10. *Terpsinoe musica,* front view: side view, Pl. 14. fig. 33.
11. *Amphipentas alternans,* side view.
12. Bodies found in flint, nature doubtful (see Pyxidicula).
13. *Pyxidicula major,* front view.
14. Moss-agate. *a, a,* silicified fibres of sponge; *b,* gemmules; *c,* branched fibre; *d,* spicula.
15. Crystalloids of chalk. *a,* simple rings; *b,* radiately striated rings; *c,* disks.
16. *Actinoptychus senarius.* *a,* side view; *b,* front view.
17. *Actinocyclus undulatus.* *a,* side view; *b,* front view.
18. *Campylodiscus clypeus.*
19. *Dictyocha gracilis,* oblique view.
20. *Dictyocha gracilis,* side view.
21. *Dictyocha gracilis,* front view.

22.–28. Fossil bodies from flint, so-called Xanthidia, but consisting of the sporangia of the Desmidiaceæ.

29. Vertical (radial) section of coal from Disco, consisting of Coniferous wood (*Pinus*).
30. Transverse section of the same coal.
31. Splinter of the same.
32. Vertical section of silicified wood (*Pinus*) from Virginia.
33. Vertical section of silicified wood (*Araucaria* ?) from Australia.

FOSSILS. Pl. 19.

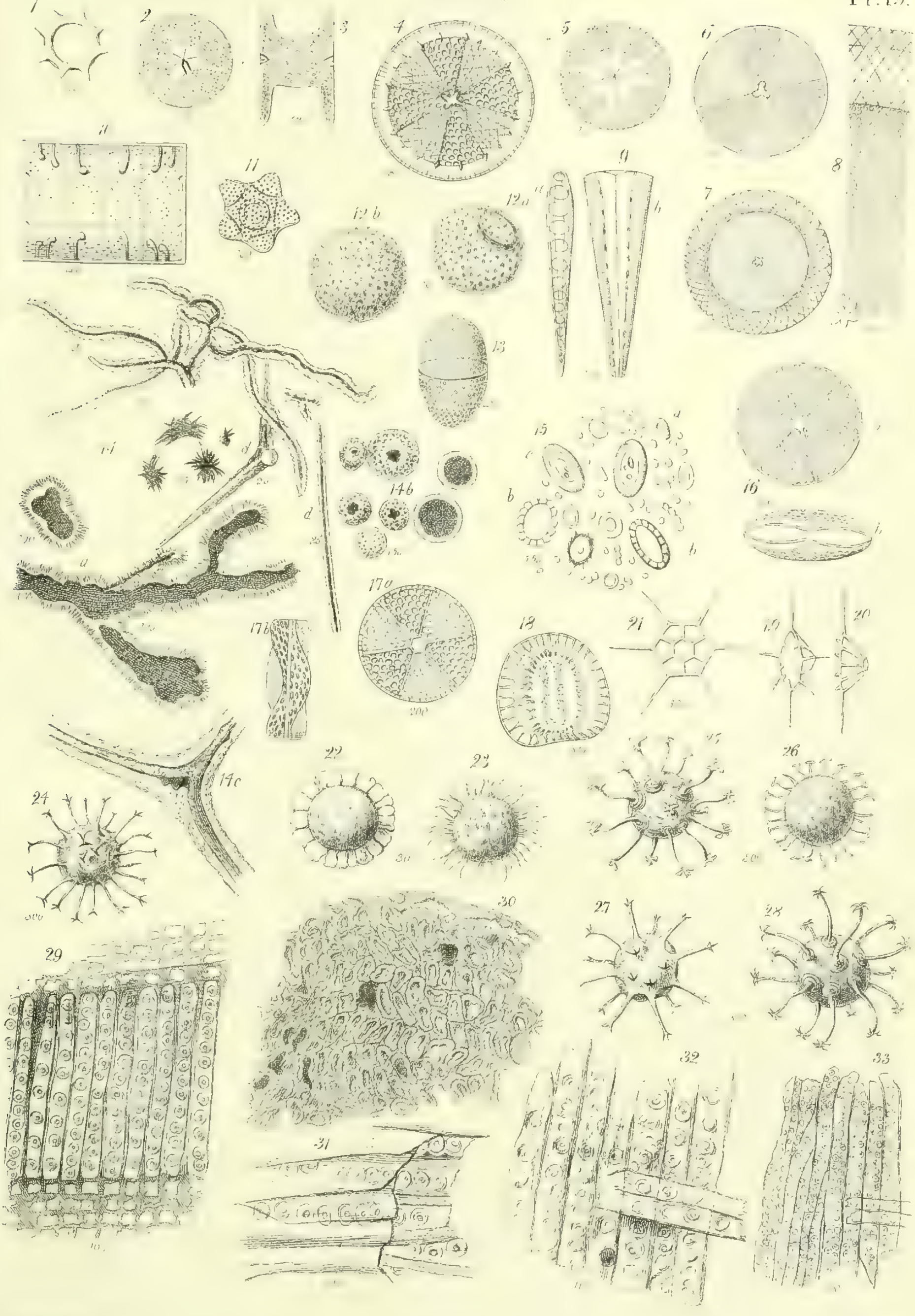

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PLATE 20.—**Fungi.**

Figure

1. Vertical section of a leaf of black currant, infested with *Æcidium grossulariæ*. *sp*, spermogonia ; *p*, perithecia.
2. Sterigmata (*st*) and spermatia (*sp*) from the spermogonia of *Æcidium euphorbiæ*.
3. Ditto, from *Æcidium berberidis*.
4. Vertical section of a spermogonium of *Æcidium berberidis*.
5. *Botrytis infestans*, young plants growing out from the stomate of a potato.
6. Full-grown plants of the same. 6 *a*, spore of ditto.
7. *Torula* ——?, growing in urine (not diabetic).
8. Grape-fungus, conidial form (*Oidium Tuckeri*) as commonly found on the leaves and fruits.

9–11. Conidia of the same, germinating.

12. Sporiferous form (*Cicinobolus*).
13. Spores from the same.
14. Hop-mildew, *Erysiphe* (*Sphærotheca*) *Castagnei*. *a*, Oidial form ; *b*, *b*, form resembling *Cicinobolus* ; *c*, *d*, Erysiphal form ; *e*, spores.
15. Fragment from the summit of a fertile filament of *Penicillium glaucum*.
16. Spores of ditto. *a*, two still united ; *b*, one detached.
17. Section of a conceptacle of *Cenangium fraxini*, containing *st*, stylospores, and *s*, spermatia.
18. Ergot of rye, *Cordyceps purpurea*, Tulasne ; fruits sprouting from the ergot.
19. Vertical section of the head of one of the fruits, bearing conceptacles in its periphery.
20. Vertical section of a conceptacle containing asci.
21. Asci removed from the same.
22. Spores from the interior of the asci.
23. Yeast-fungus (*Torula cerevisiæ*), large form at the bottom of liquid.
24. Ditto, minute form, appearing as a white mealy substance on the surface of stale beer.
25. *Sphæria inquinans* (*a*) with *Stilbospora macrosperma* (*b*) in the bark of an elm-tree.
26. A portion of the common matrix separating the two, with the stylospores of *Stilbospora* (*b*) above, and the asci of *Sphæria* (*a*) below.
27. Spore of *Stilbospora macrosperma*.
28. Spore of *Sphæria inquinans*.

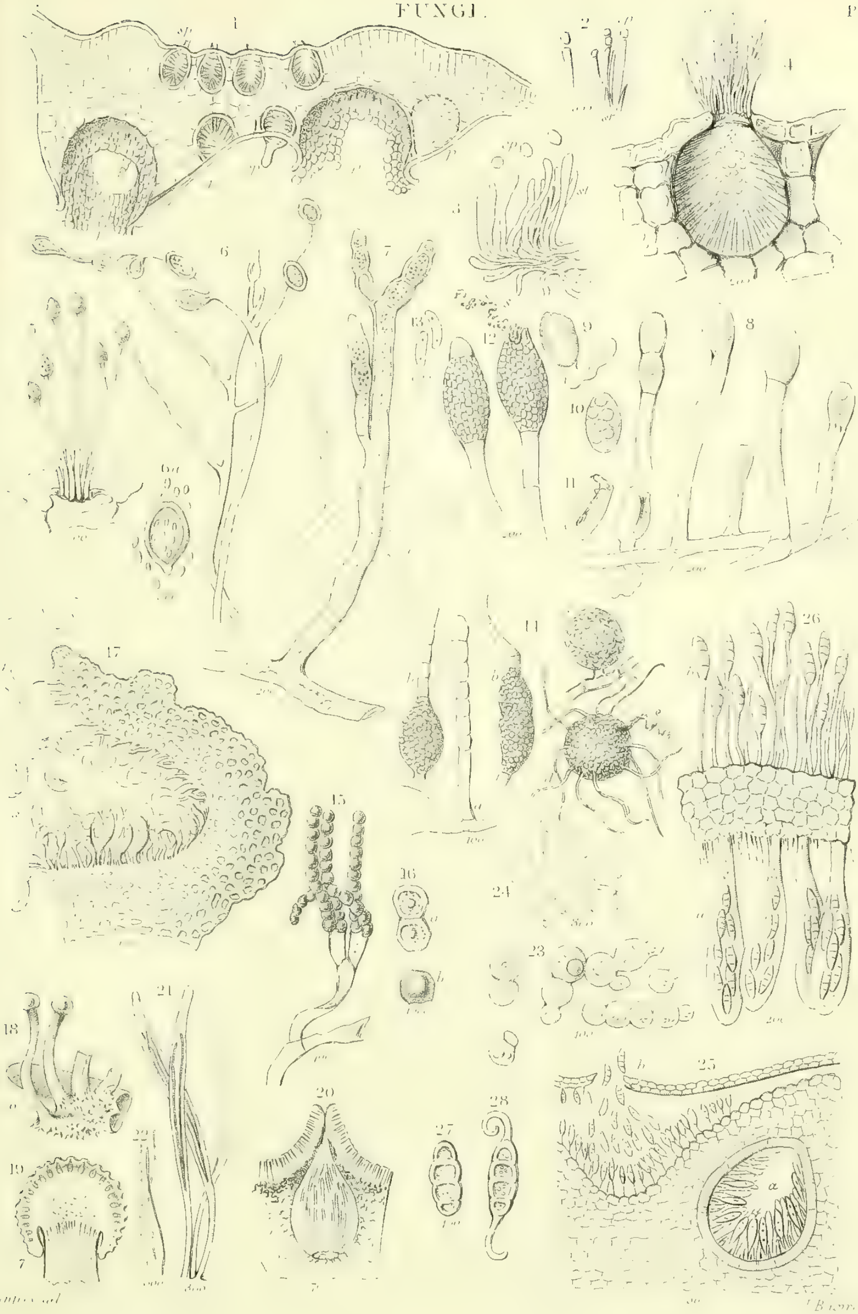


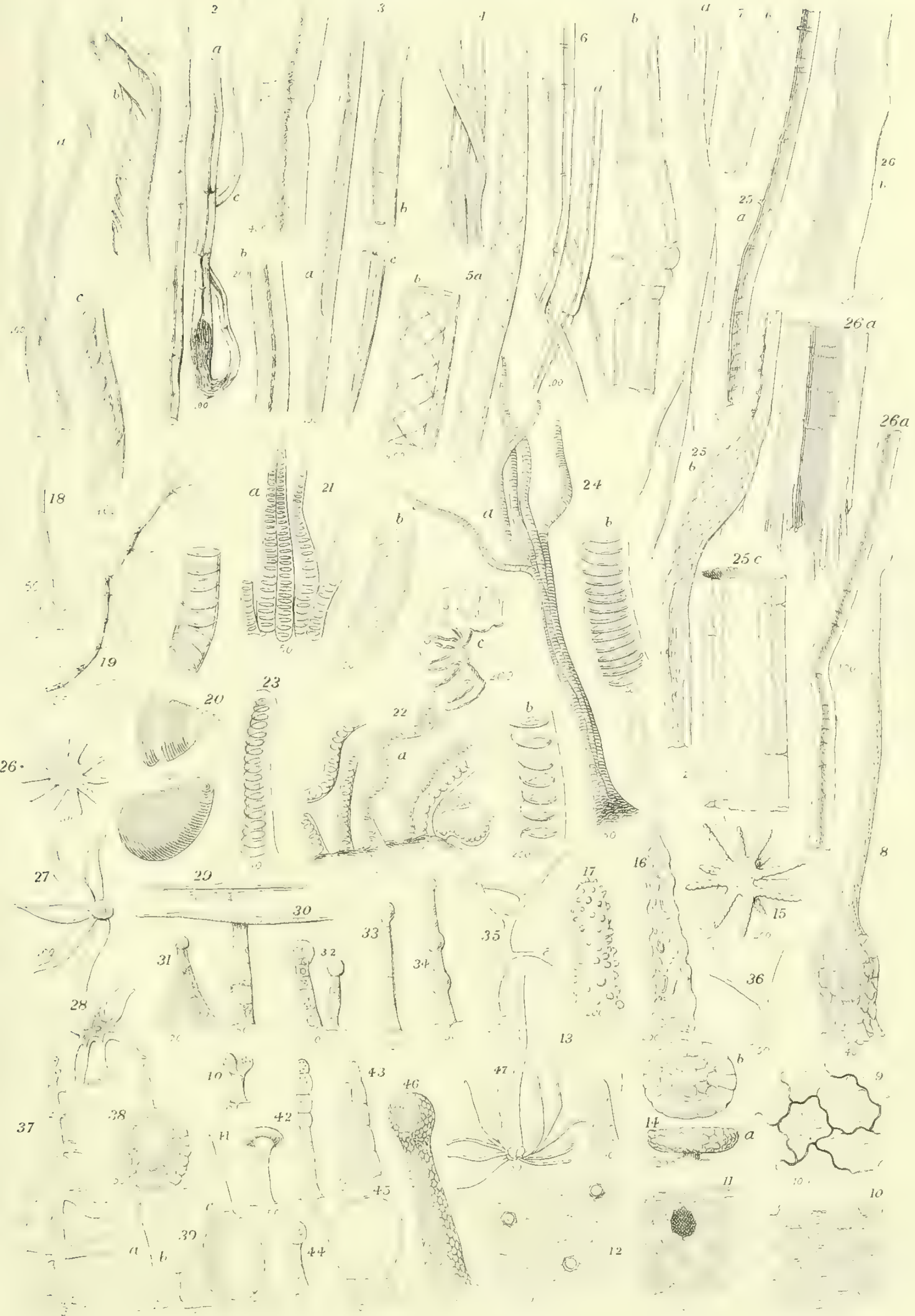
PLATE 21.—Hairs, Fibres, Glands, &c. of Plants.

Figure

1. Cotton. *a*, normal condition; *b*, portion treated with sulphuric acid and iodine; *c*, a fragment of gun-cotton.
2. Flax. *a*, normal fibre; *b*, portion boiled with nitric acid; *c*, treated with nitric acid, and afterwards with sulphuric acid and iodine.
3. Jute. *a*, normal fibre; *b*, *c*, portions boiled with nitric acid.
4. Coir (Cocoa-nut fibre), bundle of fibres.
5. Ditto. *a*, *b*, portions of fibres boiled with nitric acid.
6. Hemp. *a*, normal fibre; *b*, portions boiled with nitric acid.
7. Manilla hemp. *a*, normal fibres; *b*, fragment boiled with nitric acid.
8. Sting of *Urtica urens*.
9. Surface of the cuticle of *Helleborus fœtidus*.
10. Ditto of *Cakile americana*.
11. Imbedded gland of *Ruta graveolens*, vertical section.
12. Glands of *Magnolia*, seen from above.
13. Hair of *Siphocampylus bicolor*, the cuticle detached by sulphuric acid.
14. Glands of hop. *a*, side view; *b*, from above.
15. Stellate body from the air-spaces in the leaf of *Nuphar lutea*.
16. Hair of *Delphinium pinnatifidum*.
17. Hair of *Anchusa crispa*.
18. Hair of *Pelargonium*.
19. Branched hair of *Verbascum Thapsus*.
20. Scale-like hairs from the seed of *Cobœa scandens*.
21. Annulated hairs from the seed of *Ruellia formosa*, in water; *b*, detached cell-wall.
22. Spiral-fibrous hairs from the seed of *Collomia grandiflora*, in water. *b*, *c*, fragments showing the cell-wall and free fibre.
23. Hair from the seed of a *Salvia*.
24. Hair from the seed of *Acanthodium spicatum*. *b*, a fragment of a branch.
25. Chinese grass-cloth fibre. *a*, normal fibre; *b*, fragments boiled with nitric acid; *c*, afterwards treated with sulphuric acid and iodine.
26. Puya fibre. *a*, normal fibre; *b*, fragments boiled with nitric acid; *c*, afterwards treated with sulphuric acid and iodine.

26*. Stellate hairs from the epidermis of *Deutzia scabra*.

27. Stellate hair of ivy-leaf.
28. Stellate hair of *Alyssum*.
29. Horizontal stalked hair of *Grevillea lithidophylla*.
30. T-shaped hair of garden *Chrysanthemum*.
31. Ramentum or scale from a germinating fern.
32. Hair from the bulbil of *Achimenes*.
33. Hair from the corolla of *Digitalis purpurea*.
34. Hair from the corolla of *Antirrhinum majus*.
35. Branched hair from the epidermis of *Sisymbrium sophia*.
36. Forked hair from *Capsella bursa-pastoris*.
37. Branched hair of *Alternanthera axillaris*.
38. Gland of *Dictamnus fraxinella*.
39. Epidermis of *Dictamnus fraxinella*. *a*, *b*, hairs; *c*, gland vertically divided.
40. Glandular hair of *Lysimachia vulgaris*.
41. Glandular hair of *Scrophularia nodosa*.
42. Glandular hair of *Bryonia alba*.
43. Scale of *Begonia platanifolia*.
44. Glandular hair of *Gilia tricolor*.
45. Vertical section of papilla of *Mesembryanthemum crystallinum*.
46. Seta of a rose.
47. Tufted hair of *Marrubium creticum*.



A. Henfrey, Del.

PLATE 22.—**Hairs of Animals.**

Figure

1. Human whisker, white; air partly displaced from medulla.
2. Human hair, transverse sections.
3. Human hair, fœtal, with imbricated scales.
4. Monkey, Indian (*Semnopithecus*).
5. *Lemur.*
6. Bat, Indian.
7. Bat, Australian.
8. Mole (*Talpa europæa*).
9. Lion (*Felis leo*); left-hand figure by transmitted, right by reflected light.
10. Bear (*Ursus arctos*).
11. Wolf (*Canis lupus*).
12. Coati mondi (*Nasua*).
13. Seal, Falkland-Island (*Phocœna falklandica*).
14. Horse (*Equus caballus*).
15. Elephant (*Elephas indicus*), segment of a transverse section.
16. Pig (*Sus scrofa*).
17. *Cheiropotamus.*
18. Camel (*Camelus bactrianus*).
19. Dromedary (*Camelus dromedarius*).
20. Deer, moose- (*Cervus alces*).
21. Deer, musk- (*Moschus moschiferus*).
22. Wool, sheep (*Ovis aries*).
23. Sloth (*Bradypus didactylus*).
24. Armadillo (*Dasypus sexcinctus*).
25. Beaver (*Castor fiber*).
26. Shrew (*Amphisorex rusticus*).
27. Mouse (*Mus musculus*).
28. Ditto, treated with potash.
29. Guineapig (*Cavia cobaya*).
30. Squirrel (*Sciurus vulgaris*).
31. Rabbit (*Lepus cuniculus*).
32. Sable (*Mustela zibellina*).
33. Mink-sable (*Mustela lutreola*).
34. Badger (*Meles taxus*).
35. Chinchilla (*Chinchilla lanigera*).
36. Kangaroo (*Macropus*).
37. Opossum (*Didelphys virginiana*).
38. *Ornithorhynchus paradoxus.* *a,* entire hair; *b, c, d,* and 38*, portions, more magnified.
39. Crab (*Cancer mœnas*), from antenna of.
40. Spider (*Lycosa saccata*).
41. Spider (*Mygale*).
42. Spider (——?), from South America.

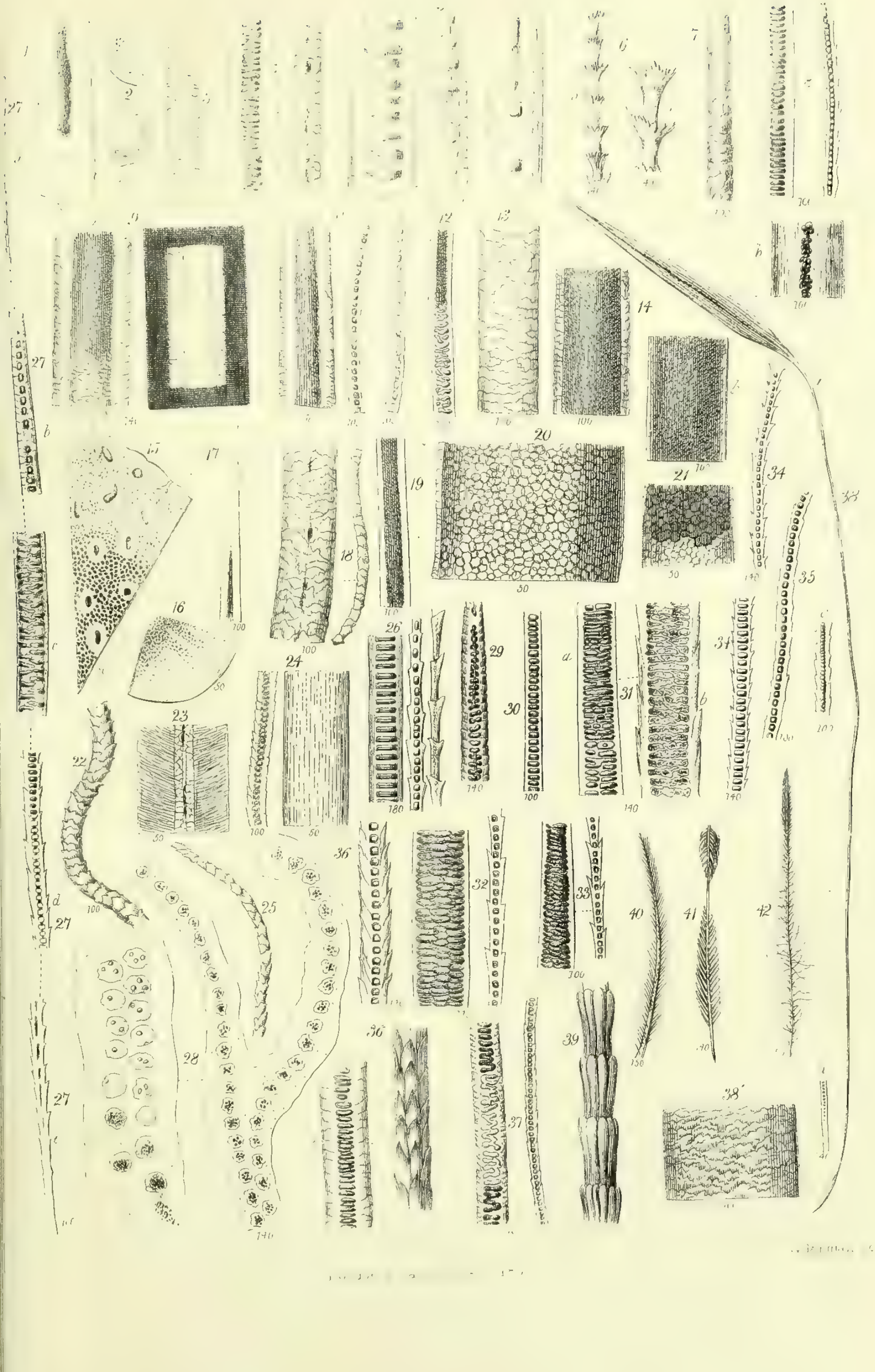


PLATE 23.—**Infusoria.**

Figure

1. *Acineria incurvata*, Duj.
2. *Acineria acuta*, D.
3. *Acomia vitrea*, D.
4. *Acineta tuberosa*, Ehr.

5*a*. *Podophrya fixa*, E.; 5 *b*, the same, or the *Podophrya*-stage of *Vorticella*?

6. *Actinophrys viridis*, E.

7*a*. *Actinophrys Eichornii*, E.; 7 *b*, *Actinophrys sol*, E.

8. *Alyscum saltans*, D.
9. *Amœba diffluens*, E. 9 *a*, expanded; 9 *b*, contracted.
10. *Amphileptus fasciola*, E. 10 *a*, dorsal view; 10 *b*, side view.
11. *Amphimonas dispar*, D.
12. *Anisonema sulcata*, D.
13. *Anthophysa Mülleri*, Bory, Duj. (*Epistylis vegetans*, E.); 13 *a*, entire organism; *b*, single body.

14*a*. *Arcella vulgaris*, E., dorsal view; 14 *b*, *Arcella aculeata*, E., under view; 14 *c*, *Arcella dentata*, E., under view.

15*a*. *Aspidisca lynceus*, E., under view; 15 *b*, *Asp. denticulata*, E., side view.

16. *Astasia hæmatodes*, E. *a*, contracted; *b*, *c*, *d*, in different states of expansion.
17. *Astasia limpida*, D. (*A. pusilla*, E.). *a*, expanded; *b*, altered in shape.

18*a*. *Bodo grandis*, E.; 18 *b*, *c*, *Bodo socialis*, E.

19. *Bursaria vernalis*, E., under surface.
20. *Carchesium polypinum*, E.
21. *Carchesium polypinum*, E., separate body.
22. *Cercomonas acuminata*, D.
23. *Cercomonas crassicauda*, D.
24. Various forms of *Trachelomonas*, arranged by Ehrenberg in the genera *Trachelomonas*, *Chætoglena*, and *Doxococcus*. See Trachelomonas.

25*a*. *Chætomonas globulus*, E.; 25 *b*, *Ch. constricta*, E.

26. *a*, *b*, *Chætotyphla armata*, E.; *c*, *Ch. aspera*, E.
27. *Chilodon cucullulus*, E. *a*, under view; *b*, side view.
28. *Chilomonas granulosa*, D.
29. *Chlamidodon mnemosyne*, E., ventral surface.
30. *Chlamidomonas pulvisculus*, E. (*Diselmis viridis*, D.), in various stages of development.
31. *Chlorogonium euchlorum*, E. (upper and lower figure), in different stages of development.
32. *Colacium vesiculosum*, left-hand figure; *C. stentorium*, right-hand figure.
33. *Coleps hirtus*, E. (*a*, after Ehr., *b*, after Duj.).
34. *Crumenula texta*, D.

35*a*. *Cryptoglena conica*, E.; 35 *b*, *Cr. pigra*, E.

36*a*. *Cryptomonas ovata*, E.; *b*, *C. lenticularis*, E.; *c*, *C. fusca*, E.; *d*, *C. globulus*, D.; *e*, *C. inæqualis*, D.

37*a*. *Cyclidium distortum*, D.; *b*, *C. abscissum*, D.; *c* and *d*, *C. glaucoma*, E.; *c*, side view; *d*, dorsal view.

38. *Cyphidium aureolum*, E. *a*, dorsal view; in *b* the expansion is seen.
39. *Difflugia proteiformis*, E., *a* and *b*.
40. *Dileptus folium*, D.
41. *Dinobryon sertularia*, E.
42. *Dinobryon petiolatum*, D.
43. *Diophrys marina*, D. *a*, under view; *b*, side view.
44. *Discocephalus rotatorius*, E. *a*, dorsal view; *b*, side view.
45. *Disoma vacillans*, E.
46. *a*, *Distigma proteus*, E.; *b*, *D. viride*, E.
47. *a*, *Doxococcus ruber*, E.; *b*, *D. pulvisculus*, E.
48. *Enchelys pupa*, E.
49. *Enchelys nodulosa*, D.
50. *Epipyxis utriculus*, E.
51. *a*, *Epistylis anastatica*; 51 *b*, single body of *E. branchiophila*; 51 *c*, less magnified.
52. *Ervilia legumen*, D. (*Ægyria leg.*, Cl. & L.; *Euplotes monostylus*, E.). *a*, under view; *b*, side view.
53. *Euglypha tuberculata*, D.
54. *Euglypha alveolata*, D.
55. *Amblyophis viridis*, E.

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PLATE 24.—Infusoria.

Figure

1. *Euglena pyrum*, E.
2. *Euglena viridis*, E. *a, b,* in different states of contraction and extension.
3. *Euglena longicauda*, E. (*Phacus longicauda*, D.), with the body twisted. Fig. 63, the same, after Duj.; the body flat.
4. *Euglena acus*, E., undergoing longitudinal division.
5. *Euplotes patella*, D. *a,* under view; *b,* lateral view.
6. *Euplotes vannus*, E., under view.
7. *Gastrochæta fissa*, D.
8. *Glaucoma scintillans*, E.
9. *Peridinium cinctum*, E.

10 *a, b.* *Glenodinium cinctum*, E.; 10 *c* (between figs. 49 & 50), *Glenodinium apiculatum*, E.

11. *Peridinium fuscum*, E.
12. *Peridinium tripos*, E.
13. *Peridinium fusus*, E.
14. *Glenomorum tingens*, E.
15. *Gromia fluviatilis*, D., with its expansions extended.
16. *Trichodina pediculus*, E. *a,* side view; *b,* under view.
17. *Heteronema marina*, D.
18. *Himantophorus charon*, E., under view.
19. *Himantophorus charon*, E., side view.
20. *Hexamita nodulosa*, D.
21. *Holophrya brunnea*, D.
22. *Holophrya ovum*, E.
23. *Ichthydium podura*, E.
24. *Chætonotus larus*, E.
25. *Colpoda cucullus*, E.
26. *Kerona pustulata*, D. (*Stylonichia p.*, E.)
27. *Kerona mytilus*, D. (*Stylonichia m.*, E.), under view.
28. *Kerona mytilus*, D. (*Stylonichia m.*, E.), side view.
29. *Stylonichia histrio*, E., under view.
30. *Stylonichia lanceolata*, E. *a,* under view; *b,* side view.
31. *Kondylostoma patens*, D., under view.
32. *Kondylostoma patens*, D., half side view.
33. *Tracheloccerca viridis*, E.
34. *Amphileptus papillosus*, E.
35. *Lagenella euchlora*, E.
36. *Cryptomonas* (*Lagenella*, E.) *inflata*, D.
37. *Leucophrys striata*, D.
38. *Leucophrys patula*, E. *a,* dorsal, *b,* ventral surface.
39. *Loxodes rostrum*, E. (*Pelecida rostrum*, D.)
40. *Loxodes dentatus*, D.
41. *Loxodes bursaria*, E., under view.
42. *Loxophyllum* (*Amphileptus*, E.) *meleagris*, D. *a,* dorsal view; *b,* anterior portion twisted.
43. *a, Microglena punctifera*, E.; *b, M. monadina*, E.
44. *a, Monas lens*, D.; *b,* the same (?) with two anterior cilia; *c, M. attenuata*, D.
45. *Nassula elegans*, E.; *b,* teeth.
46. *Nassula aurea*, E.
47. *Opalina* (*Bursaria*, E.) *ranarum*, Purk. and Val.
48. *Ophrydium versatile*, E., portion expanded by compression.
49. *Ophrydium versatile*, E., marginal portion, in the natural state.
50. *Ophrydium versatile*, E., isolated body.
51. *Ophryoglena, atra*, E.
52. *Oxytricha pellionella*, D.
53. *Oxytricha gibba*, E., side view.
54. *Oxyrrhis marina*, D.
55. *Panophrys chrysalis*, D.
56. *Paramecium aurelia*, E., dorsal view.
57. *Paramecium aurelia*, E., side view.
58. *Pantotrichum lagenula*, E.
59. *Peranema globulosa*, D.
60. *Phialina vermicularis*, E.
61. *Phialina viridis*, E.
62. *Phacus* (*Euglena*, E.) *pleuronectes*, D.
63. *Phacus* (*Euglena*, E.) *longicauda*, D.
64. *Plagiotoma lumbrici*, D.
65. *Planariola rubra*, D.
66. *Pleuronema chrysalis*, D.
67. *Plœotia vitrea*, D.
68. *Polyselmis viridis*, D.
69. *Polytoma uvella*, E.
70. *Prorocentrum micans*, E.
71. *Prorocentrum micans*, E. side view.
72. *Prorodon teres*, E.
73. *Prorodon teres*, E., teeth.
74. *Scyphidia rugosa*, E.
75. *Spathidium hyalinum*, D. (*Leucophrys spathula*, E.)
76. *Spathidium hyalinum*, D., anterior part twisted.
77. *Spirostomum ambiguum*, E.
78. *Spirostomum ambiguum*, E.; posterior end more magnified.

INFUSORIA.

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PLATE 25.—**Infusoria.**

Figure

1. Tegument of *Paramecium aurelia*, dried, showing the depressions at different foci, &c. (Intr. p. xxxiii.)

2*a*. *Paramecium aurelia*, with globules of sarcode; 2 *b*, free globule of sarcode, with numerous vacuoles; 2 *c*, the same, become reticular.

3. *Stentor Mülleri*, E.

4. *Tintinnus inquilinus*, E.

5. *Trachelius lamella*, D., *a* and *b*.

6. *Trepomonas agilis*, D.

7. *Trichoda angulata*, D.

8. *Trichodiscus sol*, E.

9. *Trichomonas vaginalis*, D.

10. *Trichomonas limacis*, D.

11. *Trinema acinus*, D.,=*Euglypha pleurostoma*, Cart.

12. *Trochilia sigmoides*, D., ventral view.

13. *Trochilia sigmoides*, D., dorsal view.

14. *Urocentrum turbo*, E.

15. *a*, *Uroleptus piscis*, E.; *b*, *U. lamella*, E.

16. *Uronema marina*, D.

17. *Urostyla grandis*, E.

18. *Uvella virescens*, E., *a* and *b*.

19. *Vaginicola crystallina*, E.

20. *Cothurnia imberbis*, E.

21*a*. *Vorticella nebulifera*, E.; 21 *b*, body separated by division; 21 *c*, body of *V. microstoma*, showing the mouth, the nucleus (auct.; testis, E.), and the contractile vesicle (vesic. seminal., E.).

22*a*. *Zoothamnium arbuscula*, E.; 22 *b*, separate body of *Z. affine*.

23. *Zygoselmis nebulosa*, D. *a*, *b*, in different states of contraction.

24. *Arcella vulgaris*, E., half side view of young, with expansions extended.

25. *Acineta*-stage of *Opercularia articulata*, E. *a*, dendritic nucleus; *b*, envelope; *c*, tentacles; *d*, vacuoles; *e*, group of fat-granules; *f*, enlarged stalk.

26. *Vorticella microstoma*, E., full-grown. *a*, œsophagus; *b*, peristome; *c*, contractile vesicle; *d*, nucleus; *e*, gemma or bud; *f*, mature bud.

27. *Vorticella microstoma*, E. (old), encysted upon its extended stalk, with its nucleus, contractile vesicle, and retracted cilia.

28. *Vorticella microstoma*, E. (young), encysted upon its contracted stalk.

29. *Vorticella microstoma*, E., encysted and stalkless. *a*, cyst; *c*, contractile vesicle; *d*, nucleus.

30. Isolated nucleus of an old *Vorticella microstoma*.

31. *Actinophrys*-stage of *Vorticella microstoma*. The cyst is partly separated from its contents; the nucleus and contractile vesicle are visible.

32. Two of the above in conjugation.

33. Two *Podophrya*-stages of *Vorticella microstoma* in conjugation.

34. Cyst of *Vorticella microstoma* discharging its brood of germs. *a*, gelatinous substance, containing *b* the germs; *c*, neck-like orifice of parent vesicle; *d*, cyst; *e*, parent vesicle.

35. *Spirochona gemmipara*, Stein. *a*, peristome with its funnel-shaped process; *b*, nucleus; *c*, gemma or bud.

36. *Acineta*-stage of the same. *a*, tentacles; *b*, nucleus; *c*, mature swarm-germ.

37. *Paramecium chrysalis*, E., undergoing longitudinal division.

38. *Glaucoma scintillans*, E., undergoing transverse division.

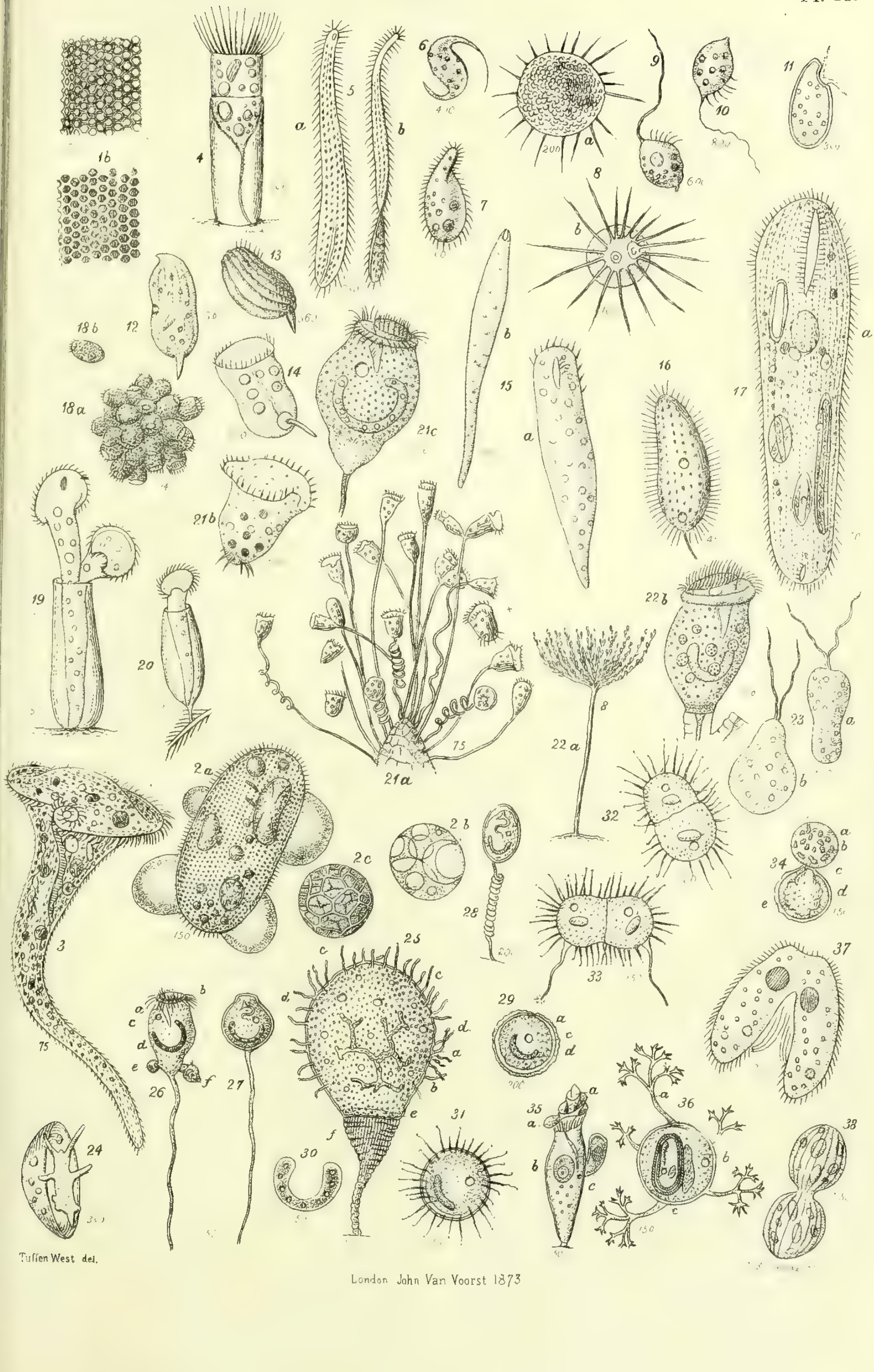

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PLATE 26.—Insects.

Figure

1. Head of *Blatta orientalis,* from before. *a,* antennæ, cut off; *b,* epicranium; *c,* eyes; *d,* clypeus; *e,* labrum; *g,* maxillæ; *h,* maxillary palpi; *k,* labial palpi.
2. Head of *Blatta orientalis,* under portion. *g,* stipes, *h,* palp of maxilla; *i,* palpiger; *k,* palp; *l,* mentum; * paraglossa of labium; *m,* submentum and gula; × occiput.
3. Head of *Hydrous piceus,* under view. *a,* antennæ; *c,* eye; *e,* labrum; *f,* mandible; *g,* maxilla; *h,* maxillary palp; *i,* ligula; *k,* labial palp; *l,* mentum; *m,* submentum; *n,* gula; × occiput.
4. Ocelli of *Agrion fulvipes.*
5. Portions of cornea of eye of *Acheta domestica.* *a,* with hexagonal, *b,* with quadrangular facets.
6. Perpendicular section of part of the eye. *c,* faceted cornea; *g,* ganglionic expansion of *n,* the optic nerve; *r,* bacilli arising from the ganglion, surrounded by choroid pigment. 6*, corneal lenses *c,* with bacilli *r,* from eye of a beetle.
7. Antenna, setaceous (Achetidæ, &c.).
8. Antenna, ensiform (Locustidæ).
9. Antenna, filiform (Carabidæ).
10. Antenna, moniliform (Tenebrionidæ, &c.). *a,* scapus; *b,* pedicella; *c,* clavola.
11. Antenna, serrated (Elateridæ).
12. Antenna, imbricated (Prionidæ).
13. Antenna, pectinated (Lampyridæ).
14. Antenna, bipectinated (Bombycidæ).
15. Antenna, flabellate (Elateridæ).
16. Antenna, clavate (Coleoptera).
17. Antenna, capitate (Coleoptera).
18. Antenna, lamellate and perfoliate (*Melolontha*). *a,* scapus; *b,* pedicella; *c,* clavola; *d,* lamellæ.
19. Antenna of *Globaria.* *a,* scapus; *b,* pedicella; *c,* clavola; *d,* capitulum.
20. Antenna, plumose (Muscidæ).
21. Antenna, plumose (*Culex pipiens,* male).
22. Trophi of *Blatta orientalis.* *a,* labrum; *b b,* mandibles; *c,* maxillæ († lacinia, * galea); *d,* internal tongue; *e,* labium.
23. Tongue of cricket (*Acheta domestica*). *a, b, c,* parts of a fibre more magnified.
24. Head of mason bee (*Anthophora retusa*), front view. *a,* antenna; *b,* ocelli; *c,* eye; *d,* clypeus; *e,* labrum; *f,* mandible; *g,* maxilla; *h,* its palp; *i,* palpiger or part of the ligula; *k,* labial palp; * ligula, commonly called the tongue; *x,* paraglossæ.
25. Maxillæ and labium of honey-bee (*Apis mellifica*). *g,* maxilla; *h,* its palp; *k,* labial palp; *l,* mentum; * ligula, commonly called the tongue.
26. Trophi of water-scorpion (*Nepa cinerea*). * lingua; *f,* mandibles; *g,* maxilla; *i,* labium.
27. Trophi of bug (*Cimex lectularius*). *a,* mandibles united; *b,* maxillæ; the median organ is the labium.
28. Antlia of red admiral butterfly (*Vanessa atalanta*). *a,* separate papilla; *b,* end of antlia extended; *c,* transverse section of antlia near its root; * ‡ tracheæ; † tube; *d,* entire organ with two maxillæ slightly separated at the end; *e,* tooth; *f,* section near the end, showing the position of the papillæ *, and the canal ×.
29. Proboscis of the blow-fly (*Musca vomitoria*). *a,* maxillary palpi; *c,* lobes of labium. 29 *a,* portion of margin more magnified.
30. Trophi of female gnat (*Culex pipiens*). *a,* antennæ; *d,* tongue; *e,* labrum; *f f,* mandibles; *g g,* maxillæ; *i,* labium.
31. Setæ of the same, more magnified. *d,* tongue; *e,* labrum; *f,* mandible; *g,* maxilla.
32. Trophi of flea (*Pulex irritans*). *d,* labrum; *f,* mandibles or lancets; *g,* maxilla; *h,* maxillary palpi; *k,* sheaths corresponding to labial palpi.
33. Trophi of flea, more magnified. *d,* labrum; *f,* end of mandible; *k,* sheath; *l,* labium; *m,* mentum.

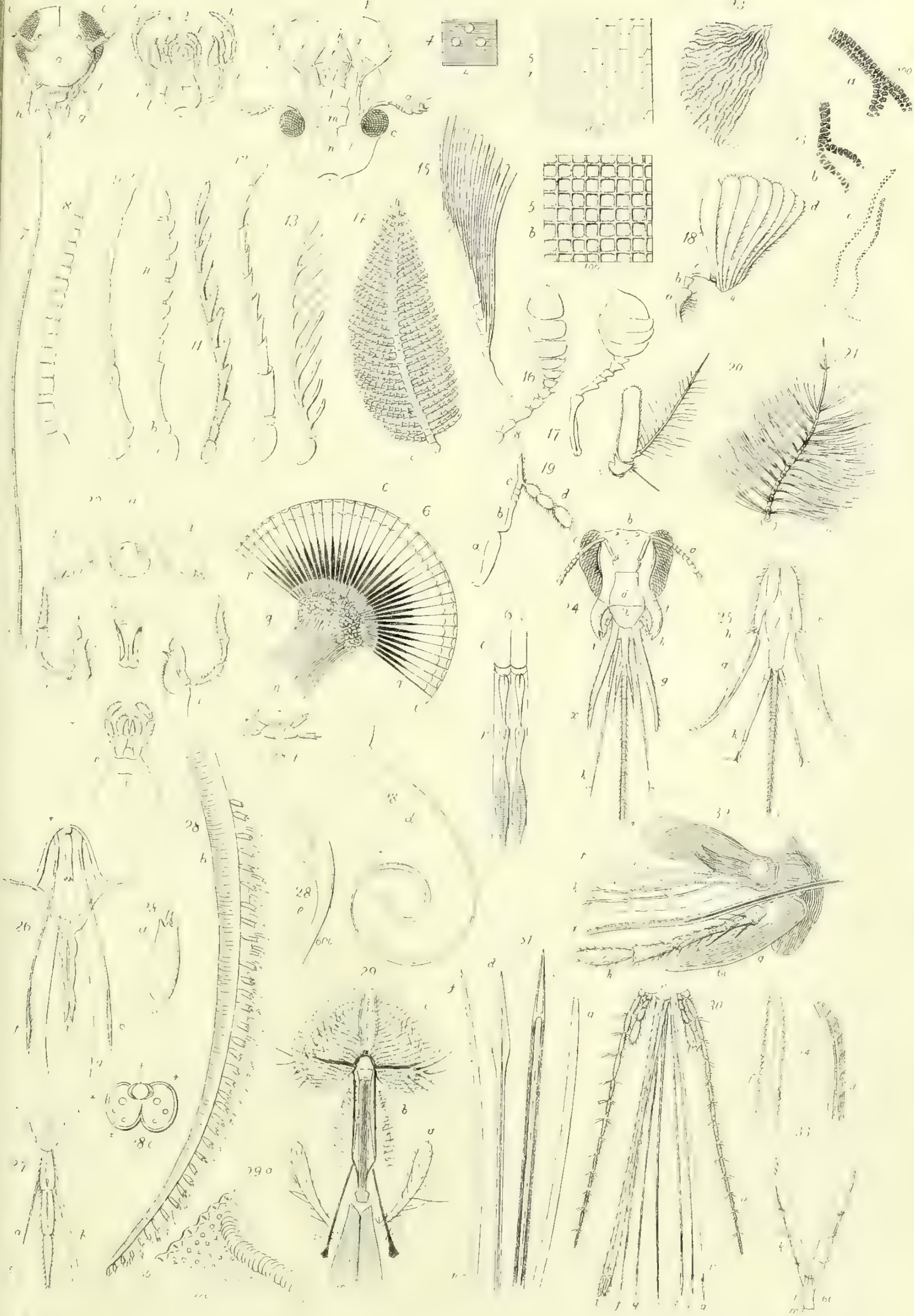

PLATE 27.—Insects.

Figure

1. Gizzard of cricket (*Acheta domestica*).

2*a*. Under membrane of elytrum of cockchafer (*Melolontha vulgaris*); 2 *b*, separate hair or spiniform papilla (ELYTRA).

3. Scale of *Lepisma saccharina*, in liquid, showing air-bubbles imprisoned by the longitudinal ridges.

4. Hind leg of neuter honey-bee (*Apis mellifica*), with pollen-brushes on the first joint of tarsus, *a*; *c*, tibia; *d*, femur; *e*, trochanter. 4 *b*, outside of tibia hollowed out.

5. Leg of middle pair of *Gyrinus natator*. *a*, tarsus; *c*, tibia; *d*, femur; *e*, trochanter.

6. Anterior leg of male *Dytiscus marginalis*. *a*, tarsus, the first three joints with the suckers; *b*, one of the smaller ones more magnified; *c*, tibia.

7. Leg of fly (*Musca domestica*). *a*, tarsus; *c*, tibia; *d*, femur; *e*, trochanter; 7 *b*, ear of cricket.

8. Tarsal pulvillus of blow-fly, with hair-like suckers.

9. One of the hair-like suckers of the same, more magnified.

10. Anterior wing of male cricket (*Acheta domestica*). *a*, drum; *b*, file (fig. 12, the file more magnified).

11. Anterior wing of humble-bee (*Bombus terrestris*). *n*, fold over which the hooks of the posterior wing play. (See INSECTS, *wings*, and WINGS, p. 833).

12. File of cricket (compare fig. 10, *b*).

13. Costal nerve of hind wing of humble-bee (*Bombus terrestris*), with the hooks. (See INSECTS, *wings*.)

14. Sting and poison-apparatus of mason bee (*Anthophora retusa*). *a b*, sheath of sting; *c*, reservoir; *d*, duct; *e*, *f*, secretory organs.

15. Single sting of wasp (*Vespa vulgaris*).

16. Spinning-organs of silkworm (*Bombyx mori*).

17. Trachea of a caterpillar; lower part of the branch containing air.

18. Internal reproductive organs of male mole-cricket (*Gryllotalpa vulgaris*). *a*, testes; *b*, vasa deferentia; *c*, *c′*, prostate (blind tubes); *d*, root of penis, with cæca (Cowper's glands) at the upper part.

19. Female organs of the same. *a*, *a*, ovaries; *b*, *b*, oviducts; *c*, receptacle of semen (blind sac), the very slender tube of which, *c′*, opens into the vagina *d*.

20. Battledore scale of *Polyommatus argiolus*, dry; 20 *a*, a portion immersed in water, and more magnified.

21. A scale of the same seen in Canada balsam.

22. Scale from the wing of the gnat (*Culex pipiens*).

23*a*. Scale from the wing of male *Pontia rapæ*, dry; 23 *b*, portion of wing of the same, showing the attachments of the two kinds of scales, *a* and *b*.

24. Scale from wing of male *Pontia brassicæ*, dry.

25. Scale from underside of wing of clothes-moth (*Tinea pellionella*).

26. Portion of wing of *Pontia brassicæ*, dry, showing the imbricated arrangement of the scales, and the wrinkling of the epidermis at their insertions.

27. Hair-like scales from clothes-moth, dry.

28*a*. Scale from wing of *Lasiocampa quercus*, dry; 28 *b*, upper portion of the same, more magnified, dry.

29. Scale from wing of *Papilio Paris*, dry.

30. Scale from larva of *Attagenus pellio*, dry.

31. Portion of the above, more magnified.

32. End of one of the posterior legs of the larva of a *Sphinx*.

33. Anterior leg of the same.

34. Spiracle of *Dytiscus marginalis*; the appended figure represents one of the marginal processes more magnified.

35. Portion of outer membrane of the ovum of the blow-fly (*Musca vomitoria*).

INSECTS

PLATE 28.—Insects.

Figure

1. Larva of gnat (*Culex pipiens*).
2. Organs of larva of *Agrion puella*. *a*, ocelli; *b*, œsophagus; *c*, gizzard; *d*, stomach; *e*, Malpighian vessels truncated; *f*, intestine and rectum; *g*, caudal branchiæ; *h*, tracheæ.
3. Clothes-louse (*Pediculus vestimenti*). } ANOPLURA.
4. *Hæmatopinus suis*; 4*, leg more magnified. } ANOPLURA.
5. *Philopterus* (*Docophorus*) *communis*. } ANOPLURA.
6. *Trichodectes latus*; 6*, labium and labial palpi. } ANOPLURA.
7. *Liotheum* (*Menopon*) *pallidum*. } ANOPLURA.
8. *Gyropus ovalis*. } ANOPLURA.
9. *Pulex felis* (flea of cat), female. *a*, spiracles; *b*, head; *c*, thorax; *d*, maxillary palpi; *e*, setæ; *f*, epimera; *g*, coxæ; *h*, trochanter; *i*, femur; *k*, tibia; *l*, tarsus; × pygidium; 9 *a*, separate antenna.
10. Part of *Pulex canis* (dog's flea). *a*, prothoracic setæ; *b*, cephalic setæ.
11. Head of flea from common bat (PULEX).
12. Antenna of flea from pigeon (PULEX).
13. Posterior end of abdomen of pigeon's flea; male (PULEX).
14. Head of larva of *Dytiscus marginalis*. *a*, eyes; *b*, antennæ; *c*, mandibles; *d*, maxillæ; *e*, maxillary palpi; *f*, labial palpi.
15. Pupa of *Ephemera vulgata*. *a*, abdominal branchiæ.
16. Larva of *Acilius sulcatus* (formerly *Dytiscus sulc.*).
17. Pupa of *Agrion puella* (LIBELLULIDÆ); 17*, caudal branchial plate.
18. *Lepisma saccharina*.
19. Larva of *Gyrinus natator*.
20. Rectum of *Æshna grandis*; 20*, portion more magnified (LIBELLULIDÆ).
21. Pupa of *Calepteryx virgo*.
22. End of abdomen of *Libellula ferruginea*.
23. Sheep-tick (*Melophagus ovinus*).
24. Flea from the mole (PULEX).
25. Head of *Geophilus longicornis* (one of the MYRIAPODA).
26. Head of a *Lithobius* (one of the MYRIAPODA).
27. Fibres of silk-worm's silk.
28. Three lobes of the fatty body of the larva (caterpillar) of *Saturnia carpini*.
29. End of abdomen of *Æshna grandis*.

30 (between 2 and 3). Epidermis of cricket (*Acheta domestica*).

31. Fat-body of *Ichneumon*-larva, developing from cells.
32. Egg of an aquatic insect (?) common in bog-water.

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PLATE 29.—Lichens.

Figure

1. Fragment of the thallus of *Parmelia parietina*, Ach., with young *apothecia* and *spermogonia* (near the edges of the lobes).
2. Vertical section of one of the *spermogonia* and the part of the thallus in which it lies. This section shows the upper and lower cortical layers of the thallus, with the intermediate filamentous medulla and its globular *gonidia*.
3. Fragment from the wall of the above *spermogonium*, more magnified to show the articulated filaments (*spermatophores*) which bear the *spermatia*.
4. *Spores* of the same, treated with iodine; the dark portion represents the protoplasmic contents.
5. A *spore* which has germinated.
6. Fragment of a vertical section through the *apothecium* of *Parmelia stellaris*, Fr. The upper part is the fertile layer, or *thalamium*, composed of *thecæ* with *spores* and *paraphyses*; this rests on the *hypothecium*, beneath which is a portion of the medullary layer, with *gonidia*.
7. Ripe *spores* of the same.
8. Ripe *spores*, germinated and not germinated, treated with sulphuric acid, and broken, showing the clear *endospore* inside the hard *exospore*.
9. Ripe *spore* of *Verrucaria nitida*, Fr.
10. Isolated *spermatia* from the *spermogonia* of ditto.
11. Ripe *spores* of *Peltigera horizontalis*, Hoffm.
12. Fragment of the *thalamium* of *Sphærophoron coralloides*, Pers., with *thecæ* in different stages of development, and free ripe *spores*.
13. Vertical section of a *spermogonium* of *Collema Jacobeæfolium*, D.C., with *spermatia* escaping. Imbedded in the thallus are seen the moniliform *gonidial* filaments.
14. Isolated articulated filaments from the same.
15. Isolated *spermatia* from these filaments.
16. Vertical section of a *spermogonium* of *Cladonia rangiferina*, Hoffm., with *spermatia* escaping from its orifice.
17. Ripe *spores* of *Urceolaria scruposa*, Ach., seen in water.
18. Fully developed *spores* of *Umbilicaria pustulata*, Hoffm.
19. Ripe *spores* of *Lecanora parella*, Ach.


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PLATE 30.—**Morbid products, human.**

Figure

1. Aphtha. *a*, spores of fungus (Oidium); *b*, fibres; *c* and *f*, *Bacterium termo*; *d*, *e*, epithelial scales; *g*, early state of *Bacterium*.
2. Areolar tissue, with formative cells and homogeneous basis; from a fibroid tumour of the upper jaw.
3. Cells of fatty tissue in degeneration. *a*, fat; *b*, nucleus; *c*, cell with thickened walls.
4. Corpuscles of pus.
5. Corpuscles of pus, treated with acetic acid. *a*, nuclei with object-glass slightly raised; *b*, the same when this is depressed.
6. Pyoid corpuscles, of Lebert.
7. Granule-cells and loose fat-globules, some of the former with distinct cell-wall and nucleus; in the lowest these are absent: from a cutaneous cancer.
8. Tubercle in lung, showing pulmonary fibres, tubercle-corpuscles, and fat-granules.
9. Tubercle-corpuscles, more magnified. *a*, seen in water; *b*, treated with acetic acid.
10. Fibroplastic cells from a sarcomatous tumour of the thigh. *a*, loose secondary cells; *b*, fusiform cells; *c*, parent cells; *d*, cell forming fibres.
11. Cancerous tissue from a medullary cancer, containing but few and pale fibres. *a*, free nucleus; *b*, nucleus within a cell.
12. Cancerous tissue from a scirrhous cancer; the fibres numerous, but delicate and not arranged in bundles.
13. Capillary vessel in a state of fatty degeneration, showing the oblong nuclei, and the minute fat-globules in the substance of the wall of the vessel.
14. *a*, fatty degeneration of the muscular bundles of the heart; the transverse striæ are absent, and globules of fat are disseminated through the substance. *b*, from muscle of the thigh, showing collapse of sarcolemma and partial absorption of muscular substance, with globules of fat in the remainder.
15. Intercellular fatty degeneration of encysted cutaneous tumour (cholesteatoma).
16. Tissue of medullary cancer of ovary. *a*, granule-cells; *b*, cancer-cells; the fibres are very few and slender.
17. Tissue of cancer of the œsophagus. *a*, cancer-cells; *b*, their nuclei (secondary cells); *c*, nucleoli (tertiary cells); *d*, cancer-cells with highly developed nuclei; *e*, granule-cells; *f*, fibres and fusiform cells.
18. Colloid or alveolar cancer of the peritoneum. *a*, nuclei or secondary cells, the walls of the two parent cells are seen at *b*; *c*, nuclei of areolar tissue; the contents of the cells are of gelatinous consistence.
19. Portion of an enchondroma, showing cells imbedded in a homogeneous basis. *a*, cell with nucleus (secondary cell) and nucleolus (tertiary cell); *c*, secondary cell with processes; *b*, secondary cell from which the primary has disappeared.

20., 21. } Cancer-cells from medullary cancer.

22. Colloid corpuscles. *a*, simple; *b*, *c*, concentric or laminated corpuscles from hypertrophied heart; *d*, *f*, laminated corpuscles from the prostate, containing calcareous matter; *e*, concentric corpuscle from a cyst in an atrophied kidney.

MORBID PRODUCTS.

PLATE 31.—**Opaque and Polarizing Objects.**

Figure

1. Two rhombs of selenite as seen under different relative positions of the polarizer and analyzer.
2. Crystals of acetate of copper (Acetic acid, Dichroism).
3. Crystals of uric acid under polarized light, natural and artificial (compare Pl. 8).
4. Prisms of ammonio-phosphate of magnesia under polarized light.
5. Ellipsoidal-constricted, or dumb-bell crystals of oxalate of lime, under polarized light.
6. Crystals of oxalate of soda, under polarized light.
7. Crystals of oxalate of ammonia, under polarized light.
8. Crystals of oxalate of chromium and ammonia, under polarized light.
9. Crystals of salicine, under polarized light.
10. Crystals of sulphate of cadmium, under polarized light.
11. Crystals of oxalurate of ammonia, under polarized light.
12. Crystals of oxalurate of ammonia, under polarized light, with a plate of selenite.
13. Elytrum of *Curculio imperialis*, as an opaque object.
14. Seeds of white poppy (*Papaver somniferum*), opaque object.
15. Seed of sweet-william (*Dianthus barbatus*), opaque object.

16., 17. Seeds of *Silene gallica*, opaque objects.

18. Seeds of foxglove (*Digitalis purpurea*), opaque objects.
19. Egg of puss-moth (*Cerura vinula*), opaque object.
20. Eggs of bug (*Cimex lectularius*), opaque objects; the lids are removed.
21. Eggs of *Pontia rapæ*, opaque objects.
22. Skin and scales of sole (*Solea vulgaris*), opaque objects.

23.–31. Polycystina. Opaque objects.

23. *Rhopalocanium ornatum.*
24. *Stephanastrum rhombus.*
25. *Eucertydium ampulla*, front view.
26. *Eucertydium ampulla*, under view.
27. *Podocyrtis Schomburgkii.*
28. *Anthocyrtis mespilus.*
29. *Astromma Aristotelis.*
30. *Lychnocanium lucerna.*
31. *Haliomma Humboldtii.*
32. Eggs of *Pontia brassicæ*, opaque objects.
33. Portion of liver of cat; the porta injected with red, the branches of the vena cava with yellow; opaque object.
34. Portion of lung of toad; opaque object.
35. Kidney of pig; arteries and Malpighian bodies red, urinary tubules white; opaque object.
36. Spiracle of *Bombyx*, opaque object.

37., 38. Sections of Rhinoceros-horn, by polarized light.

39. White hairs of horse, interlaced; by polarized light.
40. Tous-les-mois starch, by polarized light with plate of selenite.

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C. Lerman sc.

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PLATE 32.—**Pollen, etc.**

Figure

1. *a* and *b*, spiral tissue of lining of anther from wallflower (*Cheiranthus cheiri*).
2. Ditto, from London Pride (*Saxifraga umbrosa*).
3. Ditto, from *Lupinus nanus.*
4. Ditto, from a cactus (*Cereus speciosus*). *a*, side view; *b*, from above.
5. Ditto, from daisy (*Bellis perennis*).
6. Pollen of *Viola odorata.* *a*, side view; *b*, end view; *c*, in water.
7. Pollen of *Apocynum venetum.*
8. Pollen of daisy (*Bellis perennis*).
9. Pollen of *Mesembryanthemum.*
10. Pollen of *Alisma plantago.*
11. Pollen of *Lupinus nanus.*
12. Pollen of garden-geranium (*Pelargonium speciosum*). *a*, front view; *b*, side view.
13. Pollen of passion-flower (*Passiflora cærulea*). *a*, perfect grain; *b*, grain with the lid of a pore opening.
14. Pollen of *Epilobium montanum.*
15. Pollen of *Periploca græca.*
16. Pollen of *Scorzonera hispanica.*
17. Pollen of *Erica multiflora.*
18. Pollen of *Sherardia arvensis.* *a*, side view; *b*, end view; *c*, ditto in water.
19. Pollen of *Basella alba.*
20. Pollen of *Passiflora aquilegiæfolia.* *a*, side view; *b*, end view; *c*, ditto in water.
21. Pollen of *Impatiens noli-me-tangere.*
22. Pollen of *Cucurbita pepo*, in water.
23. Pollen of *Ruellia formosa.*
24. Pollen of musk-plant (*Mimulus moschatus*).
25. Compound pollen of *Acacia laxa.*
26. Pollen of *Hibiscus trionum.*
27. Pollen of chicory (*Cichorium intybus*),
28. Pollen of *Sonchus palustris*, side and end view.
29. Pollen of *Statice linifolia*, end and side views.
30. Pollen-grain with tube upon the stigmatic papillæ, from *Lathræa squamaria.*
31. Spermatozoid from the globule of *Chara fragilis.*
32. Spermatozoids from the antheridium of *Marchantia polymorpha.*
33. Spermatozoids from the antheridium of *Polytrichum commune.*
34. Spermatozoids from the antheridium of a Fern (*Gymnogramma*).
35. Spiral-fibrous cells of the sporange of *Marchantia polymorpha.*
36. Elater of *Marchantia polymorpha.*
37. Fragments of ditto. *a*, from the middle; *b*, one end.
38. Elater of *Frullania dilatata.*
39. Elaters (*a*) and spores (*b*) of *Trichia.*
40. Fragment of the same elater showing the three internal spiral fibres.

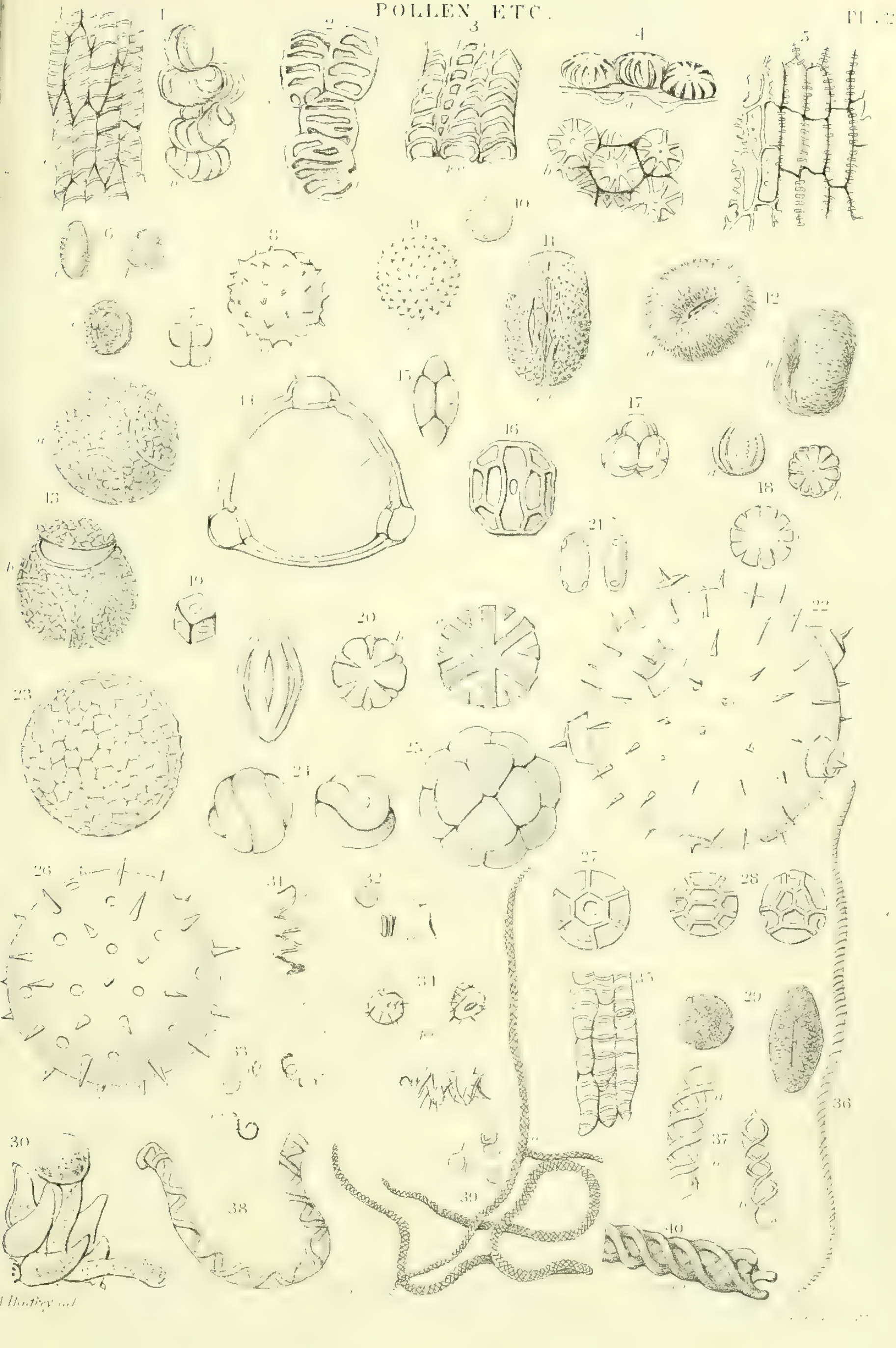

PLATE 33.—**Polypi and Polyzoa.**

Figure

1. Areolar tissue of sea-anemone (*Actinia mesembryanthemum*); with spicula, cells, and fibre-cells.
2. Spicula from the same.
3. *Alcyonella stagnorum*. *a*, entire polypidom; *b*, perpendicular section, showing tubes and ova; *c*, back view of polype with tentacles; *d*, ova.
4. *Campanularia volubilis*. *a*, growing upon a piece of *Plumularia falcata*; *b*, portion of polypidom more magnified; 4 *c*, cell of *Laomedea dichotoma* with ova.
5. *Canda* (*Cellularia*) *reptans*, portion of polypidom of. 5 *a*, *Bicellaria* (*Cellularia*) *ciliata*; 5 *b*, the same more magnified, * a bird's-head process; 5 *c*, posterior view of a cell of *Canda reptans*, with its appendices; 5 *d*, three appendices to a cell of the same; 5 *e*, polype expanded.
6. *Corallium rubrum*; axis with polypiferous crust.
7. Spicula from the crust.
8. *a*, transverse section of the axis of red coral, from the furrowed exterior towards the centre; *b*, longitudinal section.
9. Body of *Cristatella mucedo*.
10. Ova of the same, seen from above.
11. Branch of *Sertularia rugosa*.
12. Portion of the same, magnified, with cells *a*, and vesicles *b*.
13. *Sertularia pumila*.
14. Portion of the same, magnified. *a*, cell; *b*, vesicle.
15. *Sertularia operculata*.
16. Portion of the same, magnified. *a*, cells; *b*, vesicles.
17. *Lepralia variolosa*.
18. *Membranipora pilosa*. 18*, with polypes protruding from the cells; 18 *a*, cell; *b*, valve through which the ciliated tentacles *c* protrude; *d*, œsophagus; *e*, pouch containing the stomach, liver, &c.; *f*, place of gyration of particles in intestine; *g*, rectum.
19. Piece of *Flustra carbasea*.
20. Cells of the same, magnified.
21. *Hydra viridis*, attached to *Lemna*.
22. Stinging organs of *Hydra vulgaris*. *a*, capsule with the spines and filament enclosed; *b*, capsule with the spines and filament protruded; *c*, very minute capsules; *d*, capsule imbedded in a globule of the sarcodic substance of the body.
23. Tentacle of *Hydra viridis*. *a*, stinging organs *in situ*.
24. *Hydra viridis*, with spermatic capsules *a*, and ovarian capsule *b*.
25. Ovum of *Hydra*, with the young polype bursting through its shell.
26. Bird's-head processes of *Flustra avicularis*.
27. Spiculum of a *Gorgonia*.
28. Spicula of *Alcyonium digitatum*.
29. Globules of sarcodic substance of a crushed *Hydra viridis*. *a*, one containing a small vacuole and several green granules; the latter are more magnified below; *b*, a globule greatly distended by the formation of a large vacuole.
30. *Tubulipora*, with a polype protruding from a cell.

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PLATE 34.—**Rotatoria.**

Figure

1. *Actinurus Neptunius*, E., swimming. *a*, orifice of intestine.
2. Gizzard, with teeth of the same.
3. Head of the same, while crawling.
4. *Albertia vermiculus*, D.; 4 *a*, teeth.
5. *Anuræa curvicornis*, E., dorsal view.
6. *Anuræa curvicornis*, E., half side view.
7. *Asplanchna priodonta*; *b*, jaws and teeth.
8. *Brachionus amphiceros*.
9. *Brachionus rubens*, jaws of.
10. *Callidina elegans*.
11. *Callidina elegans*, jaws.
12. *Colurus deflexus*, dorsal view.
13. *Colurus deflexus*, underview.
14. *Colurus deflexus*, teeth.
15. *Conochilus volvox*, isolated animal.
16. *Conochilus volvox*, spherical group.
17. *Conochilus volvox*, jaws of.
18. *Cycloglena lupus*. *a*, tremulous bodies; *b*, contractile sac.
19. *Cyphonautes compressus*, side view. *a*, pharynx; *b*, nervous ganglion; *d*, intestine.
20. *Cyphonautes compressus*, end view.
21. *Diglena lacustris*.
22. *Diglena lacustris*, jaws.
23. *Dinocharis tetractis*.
24. *Dinocharis pocillum*, teeth of.
25. *Distemma forficula*.
26. *Distemma forficula*, jaws of.
27. *Enteroplea hydatina*.
28. *Eosphora digitata*.
29. *Eosphora digitata*, jaws of.
30. *Euchlanis triquetra*.
31. *Euchlanis triquetra*, jaws of.
32. *Floscularia ornata*.
33. *Floscularia proboscidea*, jaws of.
34. *Furcularia Reinhardtii*.
35. *Furcularia Reinhardtii*, jaws of.
36. *Glenophora trochus*.
37. *Hydatina senta*.
38. *Hydatina senta*, jaws of.
39. *Hydrias cornigera*.
40. *Lindia torulosa*.
41. *Lindia torulosa*, teeth of.
42. *Plagiognatha hyptopus*, D. (*Notommata hyp.*, E.).
43. *Lepadella emarginata*.
44. *Lepadella ovalis*, jaws of.
45. *Limnias ceratophylli*.
46. *Mastigocerca carinata*.


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PLATE 35.—**Rotatoria.**

Figure

1. *Megalotrocha flavicans.*
2. *Megalotrocha flavicans,* jaws.
3. *Melicerta ringens.*
4. *Melicerta ringens,* removed from its sheath. *a,* rotatory lobes; *b,* lips; *c,* accessory ciliated lobe; *d,* tentacular processes; *e,* pharynx or œsophagus and jaws; *f, g,* upper and lower stomach; *h,* anus; *k,* ovary; *l,* oviduct; *m,* spermatic organ? *n,* tail; *o,* disk; *p,* sarcodic globules; *q,* ovum.
5. *Melicerta ringens,* tentacular process of. *a,* setæ; *b,* conical body; *c,* muscle.
6. *Melicerta ringens,* jaws of.
7. *Metopidia triptera.* *a,* contractile sac.
8. *Microcodon clavus.*
9. *Monocerca rattus.* *a,* contractile sac; *b,* muscle.
10. *Monolabis gracilis.*
11. *Monostyla quadridentata.*
12. *Monura dulcis.*
13. *Noteus quadricornis.*
14. *Notommata centrura.*
15. *Notommata centrura,* jaws of.
16. *Œcistes crystallinus.*
17. *Philodina erythrophthalma.*
18. *Pleurotrocha gibba.*
19. *Polyarthra platyptera.*
20. *Pterodina patina.*
21. *Ptygura melicerta.*
22. *Rattulus lunaris.*
23. *Rotifer vulgaris.* *a,* contractile sac.
24. *Salpina redunca,* dorsal view.
25. *Stephanoceros Eichhornii.* *a,* tremulous bodies.
26. *Synchæta baltica.*
27. *Scaridium longicaudum.*
28. *Stephanops cirratus.*
29. *Squamella oblonga.*
30. *Triarthra longiseta.*
31. *Triophthalmus dorsualis.*
32. *Theorus vernalis.*
33. *Typhlina viridis.*

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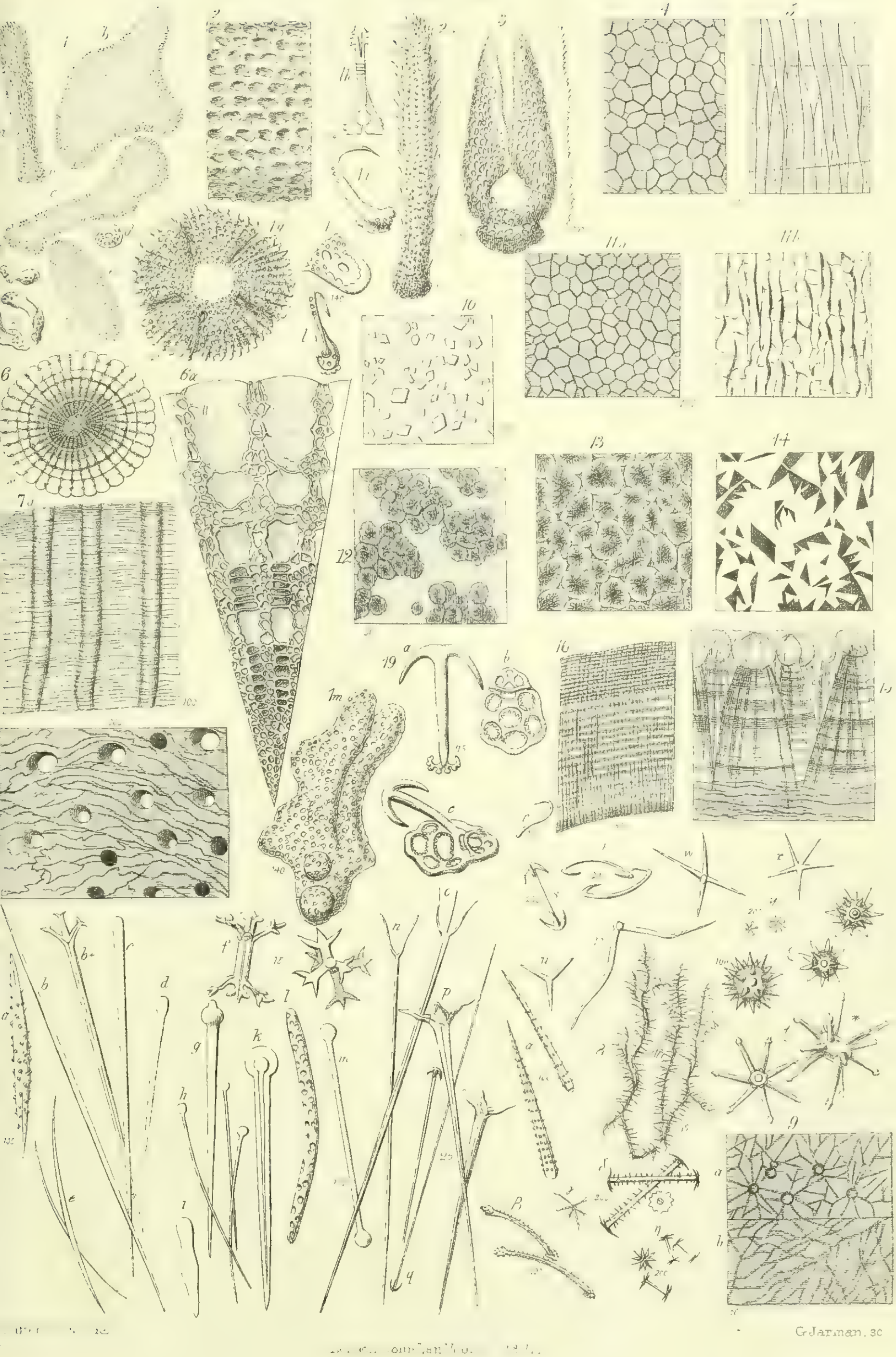
PLATE 36.—Shell, etc.

Figure

1. Calcareous corpuscles of common starfish (*Asterias* (*Uraster*) *rubens*), *a, b, c, d, e*; *f*, the same from an *Ophiura*; *g*, calcareous disk from an *Echinus*; *h, i, k, l, m*, from an *Ophiura* (Echinodermata).
2*. Spine of an *Ophiura*; 2, portion of the same more magnified.
3. A pedicellaria of the common starfish (*Asterias rubens*); on the right hand is a portion of the margin more magnified to show the teeth.
4. Shell of *Pinna*, section parallel to the surface.
5. Shell of *Pinna*, section perpendicular to the surface.
6. Spine of an *Echinus*, transverse section. 6 *a*, segment of the same, more magnified.
7. Sections of shell of a *Terebratula*; *a* perpendicular to, *b* parallel with, the surface.
8. Portion of a sponge, with the spicula projecting from its surface.
9. Shell of oyster. *a*, *b*, sections parallel to surface.
10. Shell of oyster, showing the rhomboidal crystals of carbonate of lime.
11. Shell of oyster, showing the cellular appearance; *a* parallel with, *b* perpendicular to, the surface.
12. Shell of hen's egg, from a "soft" egg.
13. Shell of hen's egg, perfectly formed.
14. Shell of egg of ostrich, section parallel to surface.
15. Shell of egg of ostrich, section perpendicular to surface.
16. Shell of lobster, section perpendicular to surface.
19. Anchor-shaped spicular hooks of *Synapta* (Echinodermata).

The remaining figures represent the spicula of sponges.

a. Elongato-fusiform, tubercular.
b. Acicular, acute at both ends.
*b**. Subulato-acicular, base trifid, rays shortly bifid.
c. Subulato-acicular.
d. Subulato-acicular, base swollen.
e. Arcuato-acicular, acute at both ends.
f. Shortly cylindrical, ends doubly trifid.
g. Subulato-acicular, base turbinate.
h. Subulato-acicular, base capitate.
i. Subulato-fusiform.
k. Elongato-subulate, base capitate.
l. Terete, geniculate.
m. Filiform, ends capitate.
n. Acicular, ends bifurcate.
o. Acicular, ends trifurcate.
p. Subulato-acicular, base triradiate.
q. Acicular, base tri-retrocuspid. *r*. Uncinato-filiform.
s. Bacilliform, ends tri-retrocuspid.
t. Arcuate, ends uncinate. *u*. Stellato-triradiate.
v. Geminate, arms subulato-filiform, geniculate.
w. Stellato-quadriradiate. *x*. Stellato-quinqueradiate.
y. Stellato-multiradiate, ends capitate.
α. Subulate tuberculate. *β*. Arcuate spinulose, ends clavate.
γ. Stellate inæquiradiate.
δ. Bacilliform spinulose, with dentate, discoid, rotate ends.
ε. Globular, with subulate spines.
ζ. Oblong, with irregularly stellate ends, the rays capitate; *side view.
η. Bacilliform, with stellate rotate ends.



G.Jarman, sc

PLATE 37.—Starch.

Figure

1. Section of a cell of the albumen of a young maize-seed, showing the nascent starch-grains imbedded in protoplasm.
2. The same, somewhat older; most of the starch-grains exhibit a central point or "hilum."
3. Section of a cell from the outer horny part of the albumen of maize; the starch-grains completely fill the cell, and by their crowded condition have compressed each other into polygonal forms.
4. Part of a similar section treated with iodine. *a*, starch-grain cut across (with a central cavity); *b*, intervening protoplasm.
5. Free starch-grains of maize from the cells of the centre of the seed.
6. Young starch-grains of ditto.
7. Compound starch-grains and separated granules, from the corm of the crocus.
8. Lenticular starch-grains of wheat. *a*, seen in face; *b*, seen edgewise.
9. Discoid starch-grains of barley. *a a*, front view; *b*, edgewise.
10. Compound starch-grains and separated granules of oats.
11. Compound grains and separated granules of Portland arrowroot (*Arum maculatum*).
12. Part of a section of a cell of the grain of rice, exhibiting very minute starch-grains, firmly compacted as in maize.
13. A portion of the same, more magnified.
14. Starch-grains of Cassava (*Jatropha Manihot*)*. Tapioca.
15. Young starch-grains from the cells of the *prothallium* of a fern (*Gymnogramma*).
16. Compound starch-grains and separated granules of the bread-fruit (*Artocarpus incisa*)*.
17. Starch-grains of *Cycas circinalis**.
18. Starch-grains of arrowroot from Singapore*.
19. Starch-grains of an East-Indian arrowroot obtained from a species of *Curcuma**.
20. Cell of a potato, showing the loosely-packed starch-grains.
21. Isolated starch-grains of the potato.
22. Starch-grains of *Tacca pinnatifida*, from Tahiti*.
23. Starch-grains of sago (from a *Sagus*?)*.
24. Starch from plantain-meal (*Musa*). *a*, front view; *b*, edgewise*.
25. Starch of Tous-les-mois (*Canna*). *a*, front view; *b*, edgewise*.
26. Starch-grains of true West-Indian arrowroot (*Maranta arundinacea*).
27. Isolated starch-grains from the cotyledon of a haricot bean.
28. Part of a cell of the stem of the white lily (*Lilium candidum*), showing nascent starch-grains: *a*, forming in cavities of the protoplasm *c*; *b*, nucleus.

* The figures to which this asterisk is appended were taken from specimens with which we were favoured from the Museum of Economic Botany at Kew.

STARCH

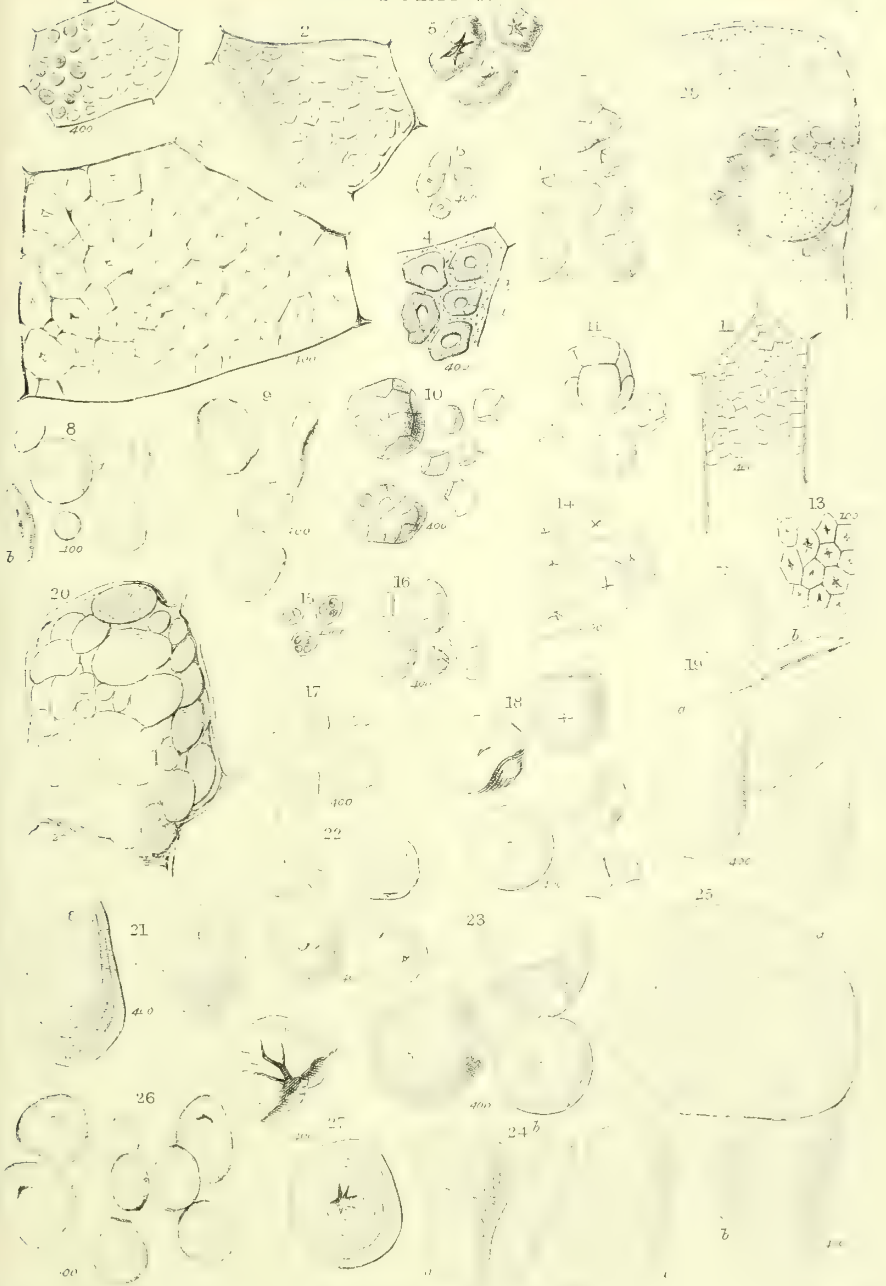


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PLATE 38.—**Vegetable Tissues.**

Figure

1. Embryo-sac, and supporting cells, of *Orchis morio.*
2. The same, more advanced.
3. The same, with a germinal vesicle at its apex.
4. The same, with three germinal vesicles, just before impregnation.
5. The same, after the pollen-tube (*p t*) has reached it, one of the germinal vesicles (*e*) already being developed to form the embryo.
6. The same, more advanced, showing the first cell of the suspensor (*s*) at the upper end.
7. Embryo-sac of *Lathrœa squamaria* before the origin of the germinal vesicles; *p*, amorphous protoplasm; *e*, protoplasm in course of development into endosperm-cells.

8, 9. Apices of very young hairs of the filaments of *Tradescantia virginica*; *n*, *n*, nuclei, containing nucleoli; *p*, protoplasm.

10. Cylindrical cell from which are formed the parent cells of the spores of *Marchantia polymorpha*; *p*, primordial utricles of the parent cells.
11. The same, converted into a string of cells.
12. One of the parent cells isolated, with four primordial utricles of the spores.
13. The four spores free.
14. Transverse section of pith and internal wood of elder; *d*, porous duct.
15. Epidermis of the leaf of the pine-apple, seen from above.
16. Vertical section of cork.
17. Transverse section of ditto.
18. Transverse section of stellate parenchyma of rush-pith.
19. Cellular tissue (parenchymatous) of the leaf of *Orthotrichum pulchellum.*
20. Cellular tissue (prosenchymatous) of the leaf of *Hypnum decipiens.*
21. Section of the albumen of the seed of *Areca Catechu.*
22. The same, after treatment with sulphuric acid and iodine.
23. Section of the bony albumen of vegetable ivory. *a*, cells and pits filled with air; *b*, cells filled with Canada balsam.
24. Cell-membrane of *Hydrodictyon utriculatum.* *l*, the laminæ of the cellulose coat; *p*, protoplasm.
25. Vertical section of the epidermis of a mistletoe-branch several years old.
26. The same, after boiling in solution of potash and treatment with iodine.
27. Transverse section of a liber-cell of the oak, after long boiling in nitric acid and treatment with iodine.
28. Vertical section of the upper face of the leaf of *Cycas revoluta.* *a*, cuticle, extending over the epidermal cells, which, like the deeper-seated cells, have pitted secondary deposits.

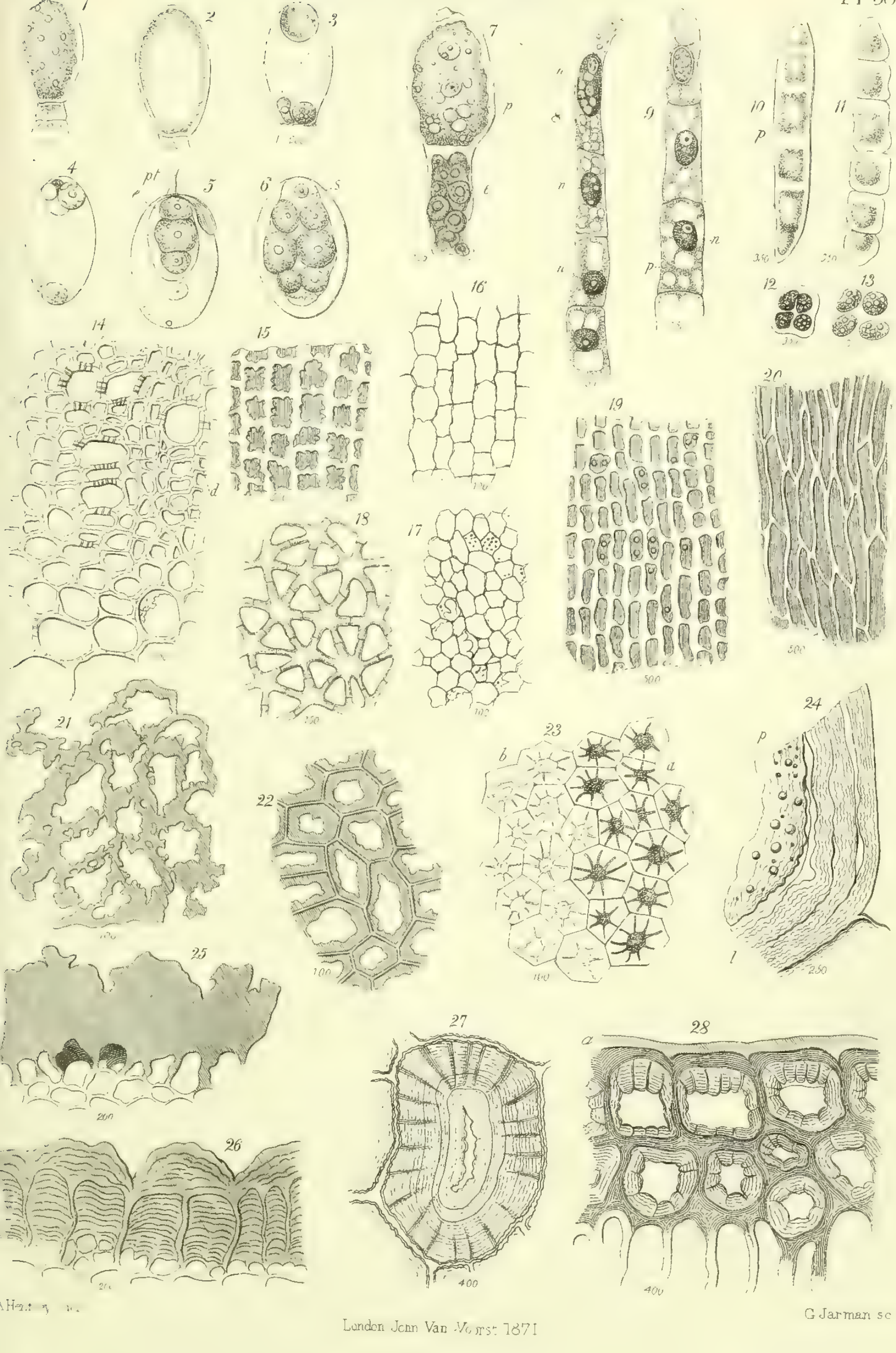

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PLATE 39.—**Vegetable Tissues.**

Figure

1. Wood of *Pinus sylvestris*. *a*, radial vertical section; *b*, tangental section of the walls of two contiguous pitted wood-cells.
2. Tangental section of the wood of *Casuarina equisetifolia*. *a*, pitted wood-cells; *b*, duct; *c*, cells of a true medullary ray; *d*, cells of one of the concentric medullary layers.
3. Vertical section of wood-cells of box.
4. Vertical (radial) section of wood-cells of the yew.
5. Vertical (radial) section of wood-cells of *Araucaria imbricata*.
6. Spiral-fibrous cells from the roots of *Dendrobium alatum*.
7. Wood-cells of *Mammillaria*, with broad spiral bands.
8. Spiral and annular vessel of Rhubarb.
9. Reticulated duct from the same.
10. Scalariform duct of a tree fern.
11. End of a spiral vessel of the white lily.
12. Fragment of a larger and looser one.
13. Pitted duct of the lime (*Tilia parvifolia*).
14. Wall of a pitted duct of *Cassyta glabella*.
15. Walls of pitted ducts of *Bombax pentandra*. *a*, next another duct; *b*, next cells.
16. Wall of a pitted duct of *Laurus Sassafras*.
17. Wall of a pitted duct of *Chilianthus arboreus*.
18. Walls of pitted ducts of Clematis (*Clematis Vitalba*).
19. End of a spiral-fibrous duct of *Daphne Mezereon*.
20. Walls of pitted wood-cells of *Cycas*.
21. Fragment of the wall of a large pitted duct of *Eryngium maritimum*.
22. Vertical section through the stomata of *Aloë ferox*. The darkly shaded part represents the cuticular layer.
23. Fragment of a latex-duct of *Euphorbia antiquorum*, the latex containing starch-grains of peculiar shape.
24. Epidermis of the petal of the daffodil, from above.
25. Fragment of the leaf of *Sphagnum cymbiforme*. *a*, empty cells with spiral fibre; *b*, interstitial cells with chlorophyll.
26. Vertical section of the upper face of the leaf of *Parietaria officinalis*, with a cystolith. Magnified 100 diameters.
27. A similar section from the leaf of *Ficus elastica*. Magnified 100 diameters.
28. *a* and *b*, sections of the cellular tissue of an onion-bulb, containing raphides.
29. Stomata and epidermis of *Equisetum*; the siliceous coat remaining after the destruction of the organic matter.
30. End of a liber-fibre of the periwinkle (*Vinca major*), with fine spiral striæ.
31. Branched liber-cell of the radicle of *Rhizophora Mangle*.
32. Siliceous cast of the inside of a duct of unknown fossil wood; the peculiar concentric concretions of the silica imitate to a certain extent the so-called glandular markings of Coniferæ.

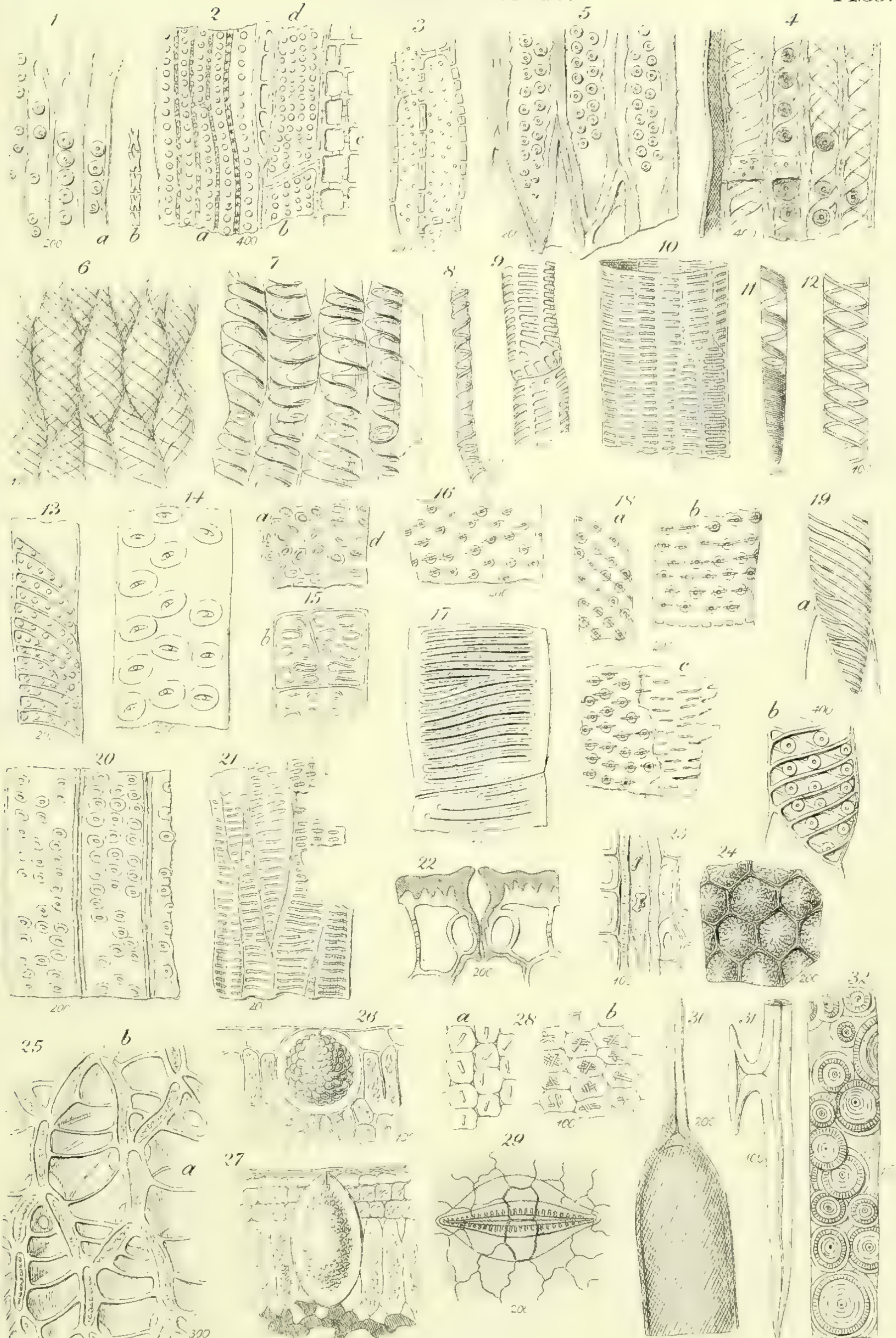

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PLATE 40.—**Various Objects.**

Figure

1. Mixtures of oil and water (INTR. p. xxxiii). *a*, water in oil; *b*, *c*, oil in water.
2. *Oceania cruciata* (ACALEPHÆ), epidermis of.
3. *Oceania cruciata*. *a*, *b*, stinging-capsules with filament included; *c*, with filament expelled.
4. *Diphyes Kochii* (ACALEPHÆ); organs of adhesion upon tentacles.
5. *Oceania cruciata*, portion of margin of disk, slightly magnified. *a*, ovary; *b*, muscular bundles; *c*, transverse vessel coming from the stomach; *d*, marginal vessel; *e*, *f*, tentacular filaments; *g*, auditory organs. Fig. 5* spermatozoa.
6. Infusorial embryos of ACALEPHÆ.

7, 8, 9, 10. The same, further developed.

11. Strobile-segments; *a*, magnified; *b*, natural size.
12. Epidermis of *Triton cristatus* (water-newt).
13. Ciliated epithelium from frog's throat.
14. *Alderia apiculosa*.
15. *Alderia pyriformis*.
16. *Hæmocharis*, epidermis of.
17. *Hæmocharis*, transverse section of muscular fibres.
18. *Hæmocharis*, muscular fibre, showing the sarcolemma.
19. *Hæmocharis*, margin of cephalic disk, with branching muscular fibres *c*, and, *a*, *b*, *d*, glands and ducts.

(ANNULATA.)

20. *Aphrodita aculeata*, hair of, treated with potash.
21. Blood-corpuscles, human. *a*, *d*, surface view at different foci; *c*, side or edge view; *b*, colourless or lymph-corpuscle; *e*, coloured corpuscles altered, either spontaneously or by mixture with foreign matters, as urine, &c.
22. Blood-corpuscles of the goat (*Capra hircus*).
23. ,, ,, whale (*Balæna*).
24. ,, ,, ostrich (*Struthio*).
25. ,, ,, pigeon (*Columba*).
26. ,, ,, stickleback (*Gasterosteus aculeatus*).
27. ,, ,, loach (*Cobitis fossilis*); *b*, colourless corpuscle.
28. ,, ,, frog (*Rana temporaria*); *b*, colourless corpuscle; *c*, *d*, the same altered by water.
29. ,, ,, triton (*Triton cristatus*); *b*, colourless corpuscle; *c*, *d*, *e*, *f*, altered coloured corpuscles.
30. ,, ,, *Siren*; *b*, colourless corpuscle.
31. ,, ,, crab (*Carcinus*).
32. ,, ,, spider (*Tegenaria domestica*).
33. ,, ,, cockroach (*Blatta orientalis*).
34. ,, ,, worm (*Lumbricus terrestris*). *a*, corpuscle partly drawn out, as occurs with the bodies of some Infusoria.
35. ,, ,, garden-snail (*Helix aspersa*).
36. ,, ,, human, coloured, undergoing division.
37. Blood, human, in coagulation; *b*, colourless corpuscle.
38. Cartilage of the ear of a mouse; the fat is partly removed from the cells.
39. Cartilage of human rib.
40. Cartilage of human epiglottis.
41. Areolar tissue, human, with fat-cells.

43. Formation of areolar tissue from cells.


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PLATE 41.—Various Objects.

Figure

1. *Chlorogonium euchlorum*, E., undergoing oblique division.
2. Elements of the chyle. *a*, molecules; *b*, free nuclei; *c*, chyle-corpuscles; *d*, one of the same with processes.
3. *Coccudina costata*, D.
4. *Anystis ruricola.*
5. Bacilli and cones of the retina of animals. *a*, *β*, from the pigeon. *a*, bacillus; *a*, proper bacillus; *b*, its pale inner extremity; *c*, line of demarcation at the boundary of the bacillar layer; *d*, corpuscle of the outer granular layer. *β*, cone; *c*, as above; *e*, bacillus of cone; *f*, proper cone; *g*, globule of fat in the same; *h*, expansion of cone. *γ*, from the frog, letters as above. *δ*, from the perch, letters as above; *i*, part at which the cone usually breaks off; *k*, radial fibre; *l*, expansion of inner granular layer. *ε*, twin cones.
6. *Frustulia membranacea.* *a*, valve; *b*, front view of frustule.
7. *Emydium testudo.* 7 *a*, isolated style; 7 *b*, claw of leg.
8. *Macrobiotus Hufelandii*: × ovary. 8 *a*. Œsophageal bulb: × its framework.
9. *Milnesium tardigrada.* 9 *a*, pharynx, with + internal buccal lobes, and † styles; 9 *b*, right posterior leg, seen from beneath.
10. *Eucampia zodiaca.*
11. *Halteria grandinella*, D., seen from above.
12. *Halteria grandinella*, D., side view.
13. *Kerona polyporum*, E.
14. *Gyges granulum*, E.
15. *Lacinularia socialis*, E.; 15 *a*, the same, more magnified.
16. Mask (labium) of *Æschna* (Libellulidæ).
17. Spermatozoa of *Triton cristatus.*
18. Sarcolemma of muscle, twisted.

19–24. *Navicula amphirhynchus* in conjugation. Fig. 19, side view of valve of parent frustule; 20, frustules in an early state of conjugation; 21, sporangial sheath; 22, sporangial sheath with parent frustules attached; 23, sporangial frustule (front view), with sheath and one parent frustule; 24, side view of sporangial frustule.

25. Spermatozoa, human.
26. Spermatozoa of rat (*Mus rattus*).
27. Spermatozoa of field-mouse (*Arvicola* (*Hypudæus*) *arvalis*).
28. Spermatozoa of rabbit (*Lepus cuniculus*).
29. Spermatozoa of goldfinch (*Fringilla* (*Carduelis*) *elegans*).
30. Spermatozoa of blackbird (*Turdus merula*).
31. Spermatozoa of wood-shrike (*Lanius rufus*).
32. Spermatozoa of a Coleopterous Insect.
33. Spermatozoa of frog (*Rana temporaria*).
34. Spermatozoa of perch (*Perca fluviatilis*).
35. Spermatic cyst of rabbit, with five globules. *a*, separate globule.
36. Spermatic cyst of rabbit, the globules containing each a spermatozoon. *a*, separate globule.
37. Spermatic cyst of the common creeper (bird) (*Certhia familiaris*), containing a bundle of spermatozoa.
38. *a*, *b*, *c*, *Staurosira construens*, E.
39. *Biblarium crux* (*leptostauron*), E.
40. *Goniothecium gastridium*, E.
41. *Periptera chlamidophora*, E.
42. *Periptera chlamidophora*, E.
43. *Aulacodiscus crux*, E.
44. *Goniothecium odontella*, E.
45. *Actiniscus sirius*, E.
46. *Rhizoselenia americana*, E.
47. *Chætoceros didymus*, E.

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G. Jarman sc.

PLATE 42.—**Various Objects.**

Figure

1. *Coscinodiscus radiatus.*
2. *Cymbella Ehrenbergii.*
3. *Arachnoidiscus indicus.*
4. *Arachnoidiscus nicobaricus.*
5. *Dictyocha fibula.*
6. *Epithemia gibba.*
7. *Podocystis americana.*
8. *Arthrogyra guatemalensis.*
9. *Acanthocystis turfacea.* *c*, forked spicula; *d*, granuliferous tentacles.
10. *Acanthometra bulbosa.*
11. *Acineta mystacina.*
12. *Acineta patula.*
13. *Actinophrys paradoxa,* with capitate (*a*) and actiniform (*b*) tentacles.
14. *Cladogramma californica.*
15. *Coscinosphæra discoplœa.*
16. *Disiphonia australis.*
17. *Liostephania rotula.*
18. *Goniothecium Anaulus.*
19. *Goniothecium barbatum.*
20. *Goniothecium didymum.*
21. *Goniothecium monodon.*
22. *Goniothecium navicula.*
23. *Goniothecium Rogersii.*
24. *Toxonidea Gregoriana.*
25. *Rhizoselenia alata.*
26. *Mastogloia lanceolata.*
27. *Eunotia tetraodon.* *a,* side view; *b,* front view.
28. *Carpenteria balaniformis.*
29. *Campylopus paradoxus.*
30. *Cadium marinum.*
31. Capillaries: *a,* cells of; *b,* nuclei.
32. *Cercaria furcata.*
33. *Clavularia Barbadensis.*
34. *Cylindrotheca Gerstenbergeri.*
35. *Cymbosira Lorenziana.*
36. *Genicularia spirotænia.*
37. *Gonatozygon Ralfsii.*
38. *Cosmocladium pulchellum.*
39. *Attheya decora.*
40. *Hydrosera triquetra.*
41. *Plagiogramma Wallichianum.*
42. *Perizonium Braunii.*
43. *Dictyosphærium Ehrenbergii.*
44. *Dimorphococcus lunatus.*

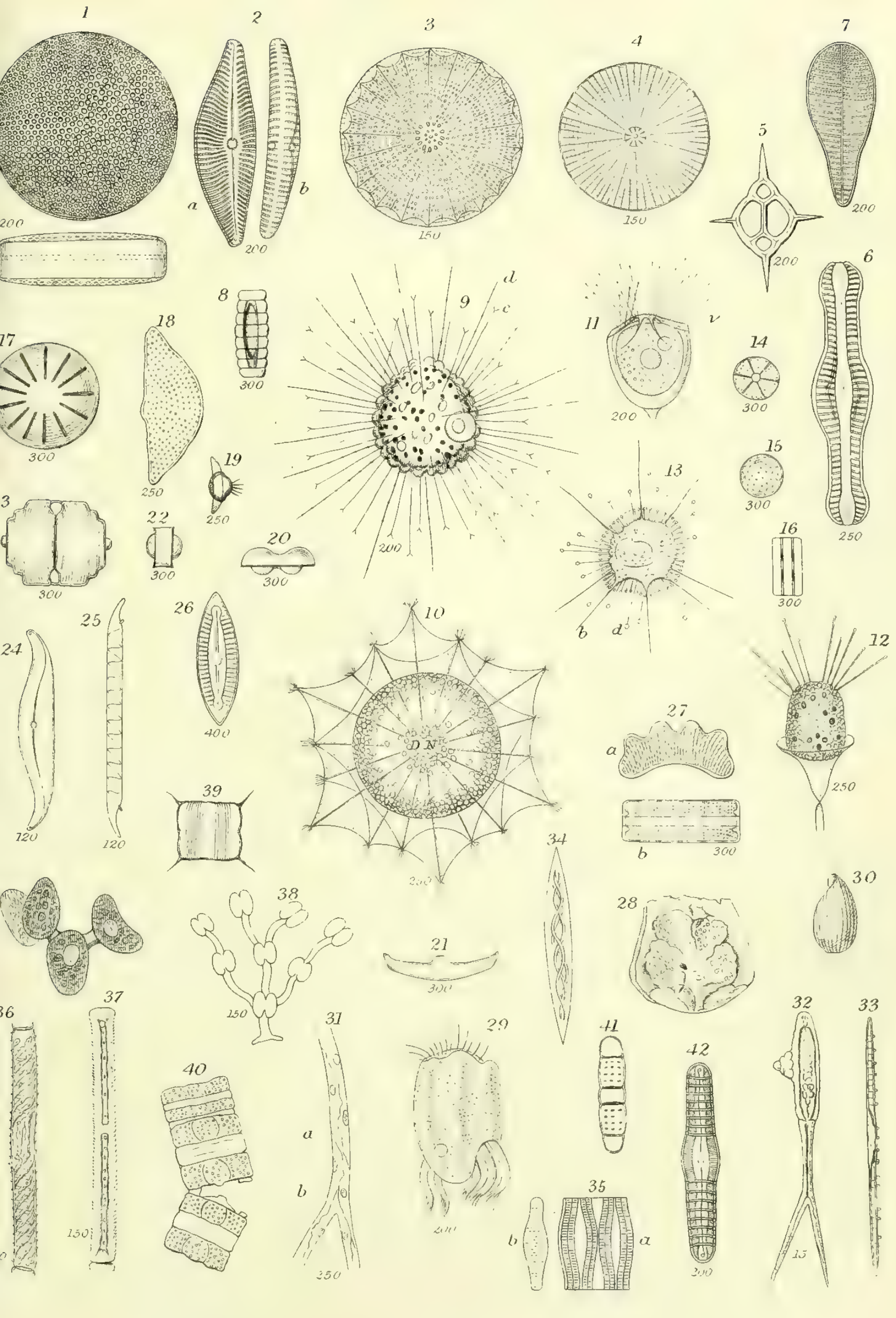
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PLATE 43.—**Diatomaceæ, etc.**

Figure

1. *Actiniscus tetrasterias.*
2. *Actiniscus pentasterias.*
3. *Actiniscus quinarius.*
4. *Actiniscus discus.*
5. *Actiniscus rota.*
7. *Anaulus scalaris.*
8. *Actinogonium septenarium.*
9. *Arthrodesmus minutus.*
10. *Amaroucium proliferum*: *a*, nat. size; *b*, individual body magnified (Tunicata).
11. *Amphicampa eruca.*
12. *Amphicampa mirabilis.*
13. *Asellus vulgaris.*
14. *Asterionella formosa.*
15. *Asteromphalos Beaumontii.*
16. *Biddulphia rhombus.*
17. *Bacillaria paradoxa* (compare pl. 12. fig. 14).
18. *Bacteriastrum curvatum.*
19. *Bowerbankia imbricata*: *a*, nat. size; *b*, portion magnified; *c*, single body.
20. *Botryllus polycyclus*: *a*, nat. size; *b*, separate body (Tunicata).
21. *Coscinodiscus* (*Craspedodiscus*) *pyxidicula.*
22. *Gammarus pulex.*
23. *Mastogonia*: *a*, *crux*; *b*, *actinoptychus.*
24. *Mastogonia prætexta.*
25. *Mastogonia hexagona.*
26. *Stephanodiscus Niagaræ.*
27. *Stephanodiscus lineatus.*
28. *Stephanodiscus sinensis.*
29. *Stephanodiscus Ægyptiacus.*

29*. *Stephanodiscus Bramaputræ.*

30. *Stephanogonia polygona.*
31. *Hercotheca mammillaris.*
32. *Syringidium bicorne.*
33. *Syringidium palæmon.*
34. *Biblarium castellum.*
35. *Biblarium compressum.*
36. *Biblarium compressum.*
37. *Biblarium elegans.*
38. *Biblarium ellipticum.*
39. *Biblarium emarginatum.*
40. *Biblarium emarginatum.*
41. *Biblarium strumosum.*
42. *Biblarium stella.*
43. *Biblarium speciosum.*
44. *Biblarium rhombus.*
45. *Biblarium lineare.*
46. *Biblarium lancea.*
47. *Biblarium glans.*
48. *Biblarium follis.*
49. *Stylobiblium clypeus.*
50. *Stylobiblium*: *a*, *b*, *clypeus*; *c*, *divisum*; *d*, *eccentricum.*
51. *Halionyx undenarius.*
52. *Odontodiscus eccentricus.*
53. *Omphalopelta areolata.*
54. *Symbolophora acuta.*
55. *Symbolophora micrasterias.*
56. *Symbolophora pentas.*
57. *Systephania corona.*
58. *Systephania diadema.*
59. *Syndendrium diadema.*
60. *Auliscus pruinosus.*
61. *Dicladia antennata.*
62. *Dicladia bulbosa.*
63. *Dicladia capreolus.*
64. *Dicladia capreolus.*
65. *Dicladia clathrata.*
66. *Periptera tetracladia.*
67. *Periptera capra.*
68. *Dictyolampra stella.*
69. *Rhabdonema arcuatum*; compound frustule.

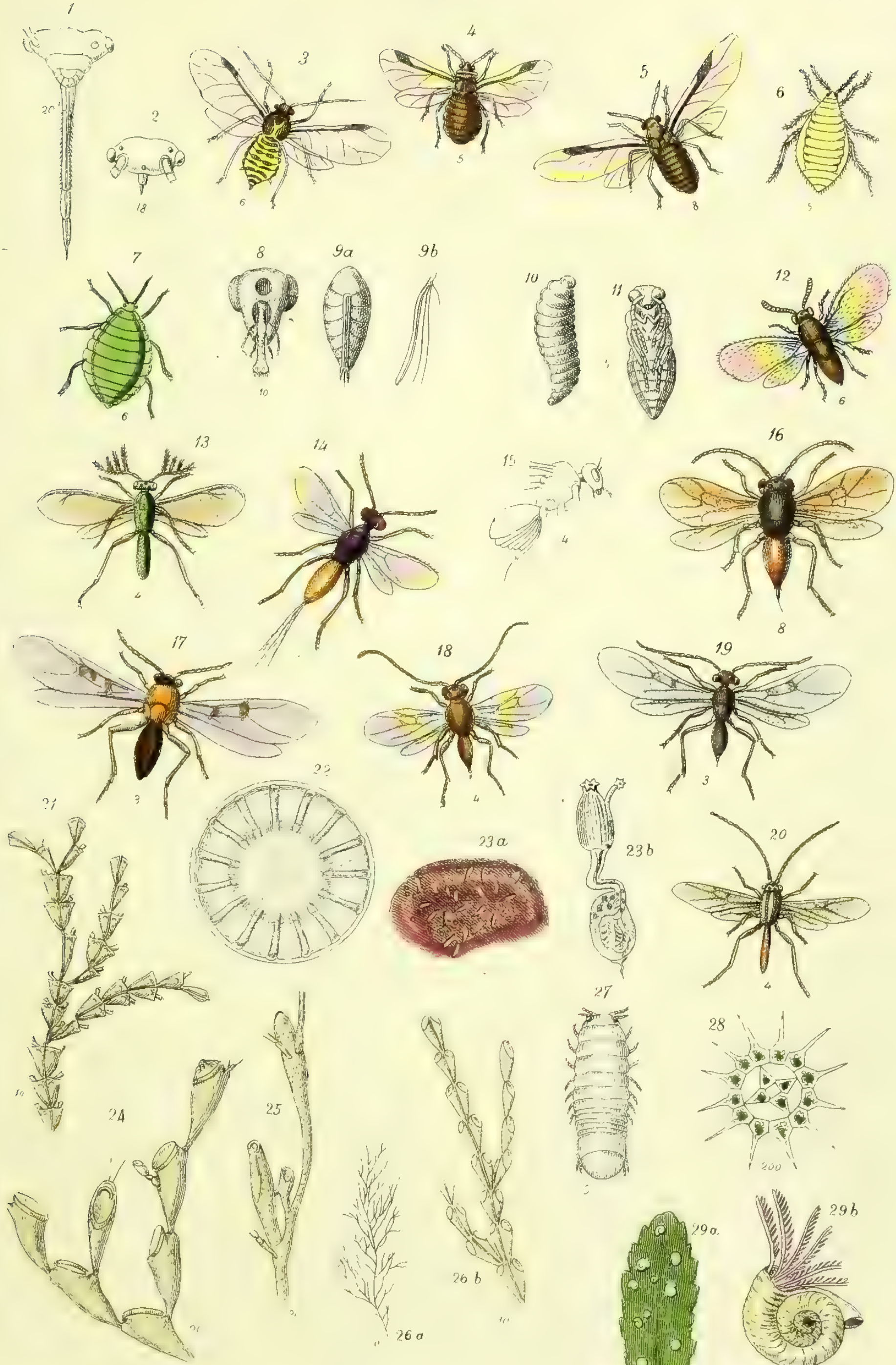
Magnified 250–300 diameters, unless otherwise expressed

PLATE 44.—**Various Objects.**

Figure

1. Head of *Lachnus*, from below (APHIDÆ).
2. Head of *Aphis*, from above (APHIDÆ).
3. *Aphis brassicæ* (APHIDÆ).
4. *Tetraneura ulmi* (APHIDÆ).
5. *Pemphigus bursarius* (APHIDÆ).
6. *Trama radicis* (APHIDÆ).
7. *Forda formicaria* (APHIDÆ).
8. *Chalcidite*, head of (CHALCIDIDÆ).
9. *Chalcidite*: *a*, under surface of abdomen of female (CHALCIDIDÆ); *b*, separate ovipositor.
10. *Eulophus nemati*, larva of (CHALCIDIDÆ).
11. *Eulophus nemati*, pupa of (CHALCIDIDÆ).
12. *Encyrtus atricollis* (CHALCIDIDÆ).
13. *Eulophus pectinicornis* (CHALCIDIDÆ).
14. *Callimome cynipis* (CHALCIDIDÆ).
15. *Cynips*, section of abdomen of female (CYNIPIDÆ).
16. *Rhodites rosæ* (CYNIPIDÆ).
17. *Cynips folii* (CYNIPIDÆ).
18. *Teras terminalis* (CYNIPIDÆ).
19. *Neuroterus longipennis* (CYNIPIDÆ).
20. *Ibalia cultellata* (CYNIPIDÆ).
21. *Notamia bursaria.*
22. *Actinodiscus Barbadensis.*
23. *Distoma rubrum*: *a*, portion of common mass; *b*, individual body.
24. *Eucratea* (*Scruparia*) *chelata.*
25. *Salpingia Hassallii.*
26. *Gemellaria loricata.*
27. *Limnoria terebrans.*
28. *Monactinus duodenarius.*
29. *Spirorbis nautiloides*: *a*, on seaweed; *b*, magnified.

INSECTS &c.



London, John Van Voorst 1872

R M Collins

PLATE 45.—Unicellular Algæ, etc.

Figure

1. *Hydrocytium acuminatum.* *a*, young plant; *b*, more advanced; *c*, older stage, with the gonidia divided; *d*, cell about to burst; *e*, cell burst and discharging zoospores.
2. *Characium Sieboldii.* *a*, *b*, *c*, successive stages of young plant; *d*, mature cell discharging its zoospores.
3. *Sciadium arbuscula.* *a*, young plants, the right-hand one setting free the gonidia of the second generation; *b*, an older plant with an umbel of secondary cells, some discharging their gonidia of the third generation; *c*, part of an umbel of cells from the last generation of a family, the gonidia being discharged as free zoospores.
4. *Chlorosphæra Oliveri.* *a*, perfect plant; *b*, a plant dividing into two; *c*, the same with the two new cells discharged from the parent.
5. *Apiocystis Brauniana.* *a*, perfect plant; *b*, zoospore; *c*, germinating plant from a zoospore.
6. *Codiolum gregarium.* *a*, young plant; *b*, nearly mature.
7. *Chytridium Olla* upon an *Œdogonium.* *a*, *a*, *Chytridia* burst and discharging their zoospores; *b*, a cell not yet open.
8. *Pythium entophytum* on *Chlorosphæra.* *a*, group, partly mature; *b*, side view of a single cell perforating the cell-wall of the *Chlorosphæra,* and with its neck opened, discharging the contents.
9. *Clathrocystis æruginosa.* *a*, *b*, *c*, fronds in successive stages of growth, the natural colour; *d*, a frond dried; *e*, highly magnified fragment, showing the minute cells imbedded in the gelatinous frond.
10. *Pandorina Morum.* *a*, side view of active form with sixteen gonidia; *b*, side view of larger form with thirty-two gonidia; *c*, end view of *a*; *d*, form with crowded gonidia after fertilization, the cilia lost; *e*, the same more advanced, having lost the gelatinous common envelope, and the cell-contents red; *f*, a single encysted gonidium (resting-spore) from *e*, more magnified; *g*, side view of a gonidium with the contents becoming converted into spermatozoids; *h*, a single spermatozoid.
11. *Ophiocytium majus,* in different stages of development.
12. Spore-formation of *Vaucheria sessilis.* A, the sporange *s*, and the antheridium *a*, not yet open; B, both open, the epoch of fertilization; C, decaying filament with ripe spore.
13. Fragment of a filament of *Œdogonium tumidulum,* consisting of antheridial cells, one discharging a spermatozoid.
14. Fragment of *Œ. ciliatum,* consisting of parent cells of androspores, one of which is escaping.
15. Fragment of *Œ. gemelliparum,* male plant, consisting of antheridial cells, some bursting to discharge their twin spermatozoids.
16. Sporange with sessile dwarf male plant of *Œ. ciliatum.*
17. The same older, the dwarf male plant *a* having burst and discharged the spermatozoid which has entered the sporangial cell.
18. Spermatozoids of *Œ. ciliatum.*
19. A dwarf male plant of *Œ. ciliatum,* discharging an androspore from its large basal cell.
20. Filament of *Œ. Braunii.* *a*, *a*, dwarf male plants, sessile on the filament; *b*, *b*, fertilized spores in the sporangial cells.
21. Ripe spore of *Œ. ciliatum.*
22. Gemmation of the resting-spore of *Bulbochæte intermedia.* *a*, ripe spore; *b*, the same enlarged; *c*, the contents dividing; *d*, the contents converted into four ciliated zoospores.

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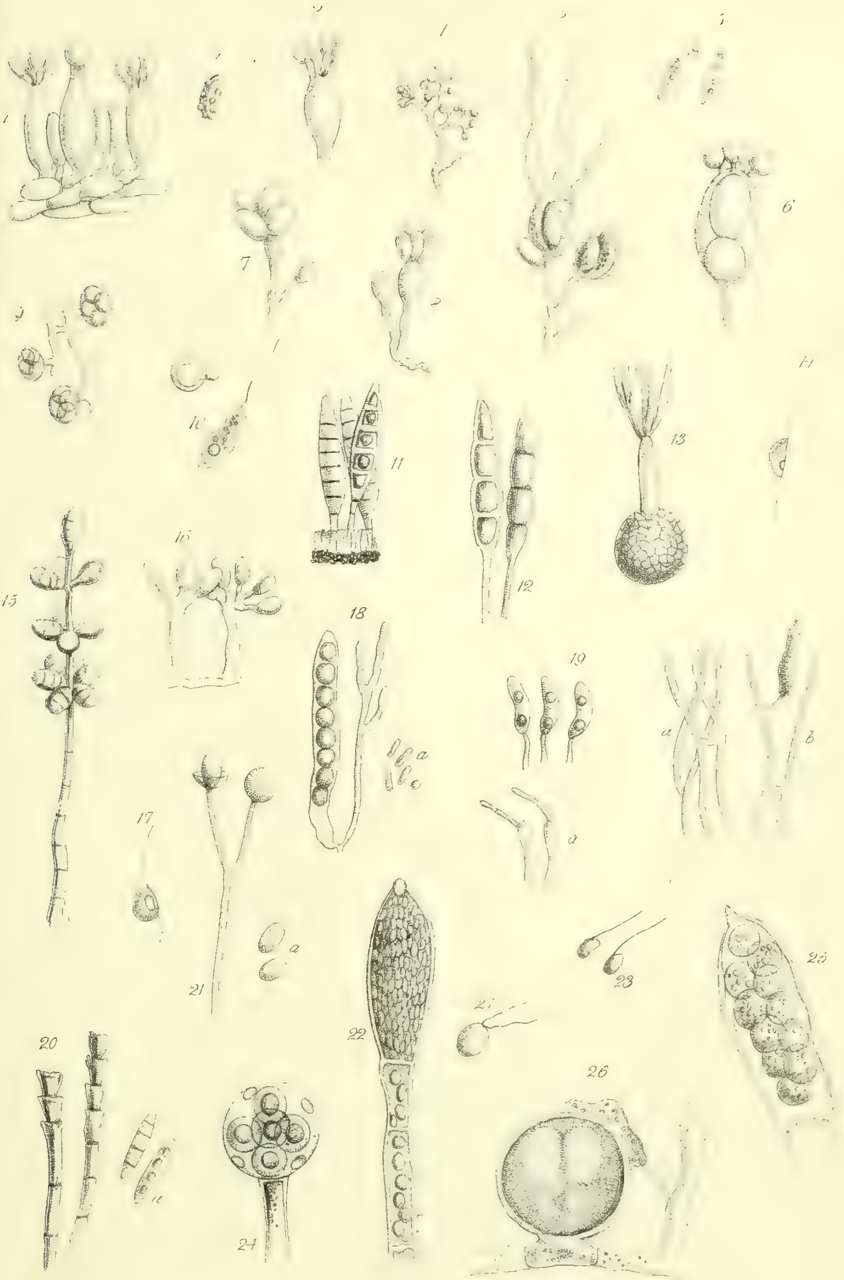
PLATE 46.—**Fungi.**

Highly magnified.

Figure

1. Part of hymenium of *Agaricus trechispora*, with sporophores, spores, and cystidium. *a*, spore.
2. Sporophore with spores of *Agaricus nebularis*.
3. Fertile threads of *Tremella mesenterica*, with lobed sporophores and elongated spicules, one of which bears a spore.
4. Threads of the same, bearing conidia.
5. Spores of *Dacrymyces sebaceus*, producing secondary spores.
6. Sporophore of *Geaster rufescens*, with its spicules and spores.
7. Sporophore of *Cyathus striatus*, with spores.
8. Sporophore of *Rhizopogon luteolus*, with spores.
9. Threads and cysts containing spores of *Enerthenema elegans*.
10. Germinating spore and amœboid of *Stemonitis obtusata*.
11. Spores springing from the wall of the perithecium in *Hendersonia elegans*.
12. Spores of *Sporidesmium atrum*.
13. Germinating pseudo-spore of *Tilletia caries*. *a*, further development of anastomosing threads; *b*, the same producing a secondary spore.
14. Zoospore of *Cystopus candidus*.
15. Thread with spores of *Spondylocladium fumosum*.
16. *Peronospora curta*.
17. Zoospore of *Peronospora umbelliferarum*.
18. Ascus and paraphysis of *Peziza hydnicola*. *a*, conidia.
19. Stylospores of *Cenangium fraxini*. *a*, spermatia of same.
20. Conidiiferous threads of *Sphæria cupulifera*. *a*, sporidia.
21. *Ascophora rhizopogonis*, with an entire and ruptured vesicle with its columella; *a*, spores of same.
22. End of thread of male plant of *Saprolegnia dioica*.
23. Spermatozoids.
24. Oogonium of same.
25. Tip of male plant of the same, producing globular bodies filled with spermatozoids.
26. Young oogonium of the same, with antheridium attached.
27. Zoospore of *Saprolegnia lactea*.

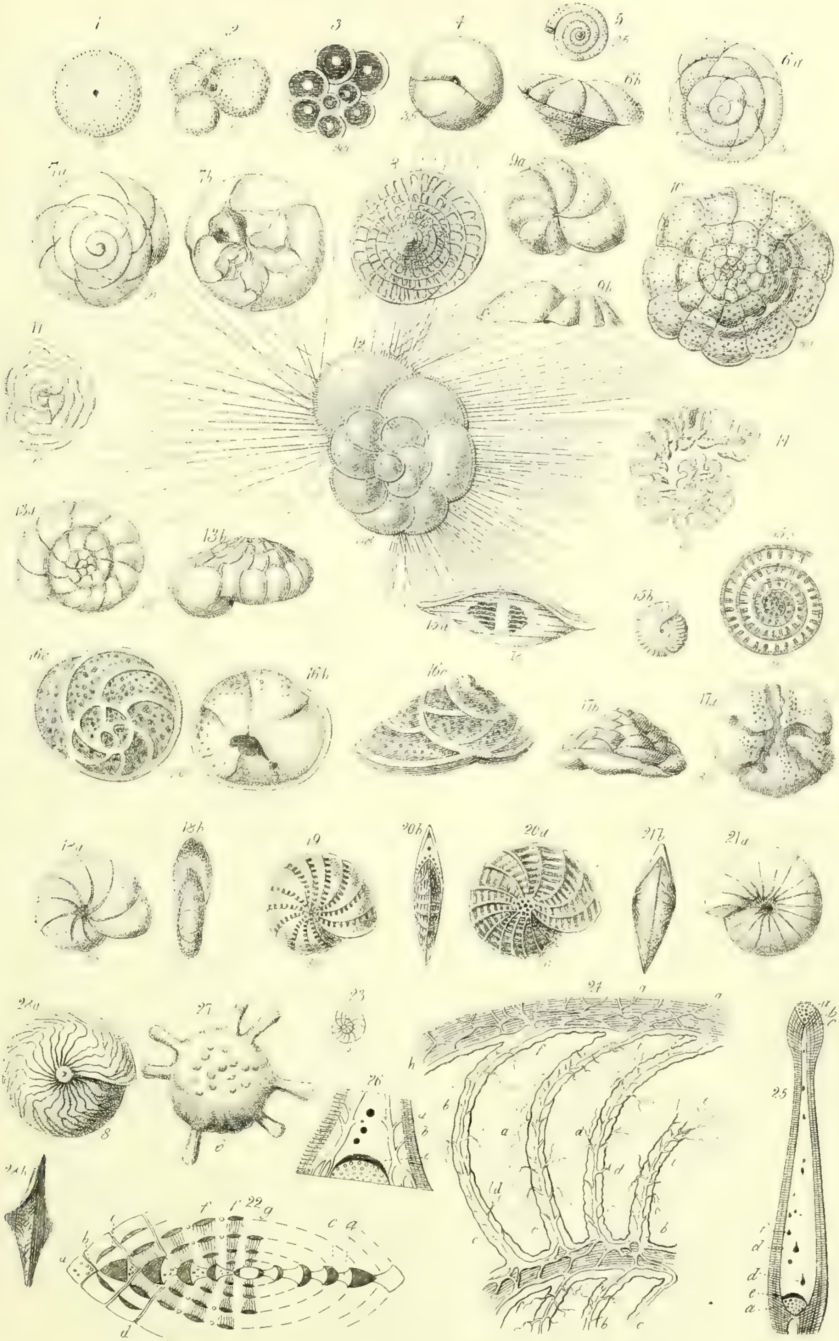


M.J.Berkeley del. G.Jarman sc

PLATE 47.—**Foraminifera.**

Figure

1. *Orbulina universa.*
2. *Globigerina bulloides.*
3. Ditto, seen by transmitted light, with air in the cells.
4. *Sphæroidina austriaca.*
5. *Spirillina perforata.*
6. *a, b, Planorbulina Haidingeri.*
7. *a, b, Discorbina rosacea.*
8. *Patellina corrugata.*
9. *a, b, Truncatulina lobatula.*
10. *Planorbulina mediterranensis.*
11. *Pulvinulina vermicularis.*
12. *Planorbulina veneta* (living).
13. *a, b, Rotalia Beccarii.*
14. Ditto ; sarcode, without shell.
15. *a, b, c, Fusulina cylindrica.*
16. *a, b, c, Pulvinulina repanda.*
17. *a, b, Cymbalopora Poyei.*
18. *a, b, Nonionina crassula.*
19. *Polystomella striato-punctata.*
20. *a, b, Polystomella crispa.*
21. *a, b, Nummulina radiata.*
22. *Nummulina acuta,* section.
23. *Operculina arabica,* nat. size.
24. Ditto, enlarged section (horizontal) of portion. } (Foraminifera.)
25. Ditto, enlarged section (transverse) of part.
26. Ditto, portion of fig. 25, highly magnified.
27. *Calcarina Spengleri.*
28. *a, b, Amphistegina Hauerina.*



Tuffen West del. G. Jarman sc.

London, John Van Voorst, 1879

PLATE 48.—**Various Objects.**

Figure
1. *Freia elegans.*
2. *Gerda glans.*
3. *Gomphogramma rupestre.*
4. *Heibergia Barbadensis.*
5. *Hydrianum ovale.*
6. *Hydrocoleum helveticum.*
7. Transverse section of the SPINAL CORD, after Lockhart Clarke. *a*, antero-lateral columns (white substance); *b*, posterior column; *c*, posterior cornu (grey substance); *d*, anterior cornu; *e*, posterior commissure: in front is the central canal and the anterior commissure; *f*, posterior nerves; *g*, anterior nerves.
8. *Hypheothrix*, species of.
9. *Mastigocladus laminosus.*
10. *Mastigothrix æruginosa.*
11. *Metopus sigmoides.*
12. *Mischococcus confervicola.*
13. *Liradiscus Barbadensis.*
14. *Limnodictyon Rœmerianum.*
15. *Urnula epistylidis.*
16. *Petalopus diffluens.*
17. *Plagiophrys cylindrica.*
18. *Pleurococcus vulgaris.*
19. *a*, *Rhoicosphenia curvata*; *b*, *marina.*
20. *Schizopus norvegicus.*
21. *Staurogenia quadrata.*
22. *Stephanosphæra pluvialis.*